A Visual Language for the Modelling of Service Delivery Processes to Support Business Processes Management

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Abstract—**Business process management aims to align the business processes of an organisation with customers' needs. Such alignment is of particular importance for services and requires a good understanding of the interactions among the actors involved. Although several process modelling languages and a service design technique called 'service blueprint' provide good support for modelling of service delivery processes, the actual execution of service and networked interactions among actors seem to have not been sufficiently considered. To overcome these limitations, we developed the Service Journey Modelling Language. Each version of the language has been evaluated, and the results were used as input for the next version. Results from our case studies show that our language might supplement the management of business processes for services by aligning business processes with customer perspectives and by supporting depiction of the actual service journeys with networked interactions of involved actors using appropriate visual representations.**

Keywords-business process management; service; process modelling; service design; visual language.

I. INTRODUCTION

This paper is an extended version of 'Can Business Process Management Benefit from Service Journey Modelling Language?' that was published in the proceedings of the Eighth International Conference on Software Engineering Advances [1]. While the original paper investigated if and how a visual language that presented the customer journey through a service might be useful for aligning the business processes of service providers with the expectations of customers, this paper extends the scope, investigating how such a language can support the modelling of a service delivery process characterised by many steps, actors, and interactions among them. In this paper, we distinguish services from products. Services have characteristics that are intangible, extended in time, and delivered across various interfaces.

The importance of services in businesses has grown worldwide [2]. The same trend can be seen in the European Union (EU), where services generate approximately 70% of the EU's GDP and employment [3].

Business Process Management (BPM) is a systematic approach to support the design, enactment, management, and analysis of operational businesses processes [4]. It defines business processes, shows the interactions among them, and models the organisational structure [5]. The core concepts in BPM are efficiency and adaptability. BPM is a collaborative effort that involves people and their use of systems in an organisation in pursuit of the organisation's goals. The main goal of BPM is to increase the productivity and efficiency of the organisation's work.

According to Verner [5], there is a lack of techniques for designing, analysing, and simulating business processes. She argued that process modelling languages are the key elements for solving this problem [5]. The importance of service in our economy emphasises the need for a good understanding of BPM in the context of services.

Several process modelling languages have been used in practice. Basic flowchart, UML activity diagram, and Business Process Modelling Notation (BPMN) are some examples. However, the customer's point of view does not seem to be included in most of these languages.

Service blueprint, a process-based technique from service design, has been developed to illustrate the customer's point of view, but the interactive and dynamic nature of service delivery processes are difficult to capture in the service blueprint model [6]. There is a lack of service design techniques in which the actual execution of a service, as opposed to a presumed or expected execution, can be represented or described.

Moreover, most existing tools for business process modelling and service design are rooted in a dyadic relationship (one customer and one provider); whereas today's fragmented service models have other relationships (one customer and many service providers or actors due to outsourcing, specialisation etc.). Tax et al. introduced the concept of a service delivery network (SDN) and defined it as 'two or more organisations that, in the eyes of the customer, are responsible for the provision of a connected overall service experience' [7]. This implies that there is a need for description formats that take a network perspective rather than a dyadic perspective.

In addition, there is a need for a process modelling language with sufficient graphical capacity to support the description of service delivery processes. Service blueprint requires greater visualisation capacity to include more information in a service delivery process [6].

In short, we believe that service providers need an appropriate process modelling language that i) takes into account the service customer's point of view, ii) enables the presentation of the actual execution of the service delivery process, iii) considers the actor network perspective of service provision and consumption in the description format,

and iv) has rich enough graphical capacity. We believe that such a language will eventually contribute to supplement BPM for services.

We developed a visual domain specific language, called Service Journey Modelling Language (SJML). SJML aims to support the analysis of existing services and the design of new services [8]. SJML contains terminology (semantical attributes), graphical attributes (symbols), syntactical attributes, and grammar (rules). To evaluate the very first version of the language, we organised a workshop with the staff of a university library, focusing on describing and redesigning existing services [1]. The language has been further developed by project members through discussions and workshops, and it has been evaluated in two case studies involving an eMarketing company and an energy providing company [8].

This paper extends our previous work by investigating how such a language can support the modelling of service delivery processes characterised by many actors and steps, and how to describe highly complex service delivery processes appropriately. To do this, we conducted a case study with a referral process. A referral process is the process of transferring the care of a patient from one medical expert to another [9]. We used our language to describe an electronic referral process in a Norwegian hospital. Several challenges were identified. To address them, we further extended the language.

The rest of this paper is organised as follows: Section II describes the theoretical background and related work in the areas of business process modelling and service design techniques for process modelling. Section III presents the overall requirements for SJML and describes a case study with SJML v1.0. Section IV shows the development process of SJML v2.0 with details of a case study. In Section V, we present and discuss the results from our case studies. Section VI discusses the limitations of this study. Section VII concludes this paper and proposes future work.

II. RELATED WORK

Our work spans quite a number of different disciplines, and we have chosen to focus on the following: service design, information visualisation, communication theory, and modelling languages. In subsection A, we introduce the theoretical background of the abovementioned four disciplines that are related to our research. In subsection B, we describe some existing process modelling languages that demonstrate the sequence of steps in a business process. In subsection C, we introduce a service design technique that has been used to illustrate service delivery processes. In subsection D, we discuss the previous mentioned process modelling languages and the service design technique, concluding that there is a need to develop a new language.

A. Theoretical Background

In this subsection, we introduce the theoretical background of our research. Relevant knowledge from the areas of service design, information visualisation, communication theory, and modelling languages is explained.

1) Service Design Phases

Services are designed in an iterative manner [10][11][12]. The design of services consists of several phases. Dubberly and Evenson. introduced five steps (observe, reflect, make, socialise, and implement) [12], and Stickdorn and Schneider introduced four phases (exploration, creation, reflection, and implementation) [13]. The service delivery processes are specified prior to implementation. However, the 'fuzzy front end' in service design and development has been problematic; thus, there is a need for a methodologically structured way to present the service delivery processes [14].

We aim to research how to assist the activities of specifying, describing and analysing the service delivery processes to support the service design phases. Information visualisation, communication theory, and modelling languages have formed a theoretical basis for our research.

2) Information Visualisation

Visualisation originally meant forming a mental picture of something [15]. Information visualisation is a visual representation of abstracted data and concepts that include numerical and non-numerical data. A good example of information visualisation is weather forecasting. Moreover, information visualisation increases human cognition [16] by providing (interactive) visual representation of data or concepts. The term has slightly shifted in meaning from being an internal construct of the mind to an external artefact supporting understanding and decision-making.

Pictures are routinely used to present information in different fields such as medicine, architecture, geography, statistics and design. One of the advantages of using pictures in this way is that a large amount of complex information can be quickly interpreted if presented effectively. Information visualisation helps people easily understand complex information and changes over time that would otherwise be difficult to comprehend [17]. Extensive research suggests that in many application domains like reverse engineering, software restructuring, and information retrieval, information visualisation may improve efficiency, accuracy, and user satisfaction when solving complex tasks [18][19].

By adopting Ware's advantages of information visualisations [20] and Bitner et al.'s gaps model of service quality [21], some expected advantages of information visualisation in the context of describing service delivery process could be:

- Important information about the described service delivery process would be easy to understand.
- Gaps between the expected or prescribed service delivery process and the actually delivered service process will be emphasised.
- Identification of problem areas in need of improvement in a service delivery process will be facilitated.

3) Communication Theory

Communication is the process of sending and receiving messages or transferring information from a sender to a receiver. It is often described in accordance with the sender/receiver-model developed by Shannon and Weaver [22]. The model consists of eight key elements required for communication: source, encoder, message, channel, decoder, receiver, noise and feedback, see Figure 1.
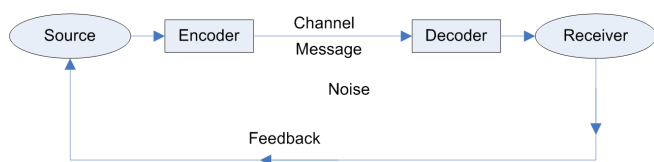

Figure 1. Shannon-Weaver's model of communication

The source of communication is the initiator – an individual or group - with a message or specific intention to start the communication process. The message is communicated from the source to an intended receiver. The encoder provides the format of the message. The channel is the mediator of the message and makes sure it is transmitted to the receiver. To illustrate, the channel may be verbal, written, or electronic. Noise may disturb the transmission during the communication process. It could be physical noise, like in actual sound transmission. However, it can also be semantic noise, for example if the receiver cannot understand the message. Before reaching the destination, the message must be interpreted or decoded. Feedback indicates whether the message has been received and interpreted accurately. It ensures that the source knows whether the communication was successful.

Although this linear model was developed in a time with no multimedia and interactive environments, it is still a widely accepted model when drilling down a communication process in its bits and bytes. However, the model lacks the relational and cultural factors, so it appeals more towards the technological perspectives such as in the development of information retrieval systems. Craig describes communication theory as a non-coherent field, distinguishing seven different traditions or approaches that contribute significantly with their characteristic ways of defining communication and related challenges [23]. These seven traditions are referred to as rhetorical (the practical art of discourse), semiotic (inter-subjective mediation by signs), phenomenological (experience of otherness and dialogue), cybernetic (information processing), socio-psychological (expression, interaction, and influence), socio-cultural (production of social order), and critical (discursive reflection) traditions.

Semiotics is the study of signs, sign processes, and how signs take part in communication. Although semiotics and communication have a wide intersection in terms of the general phenomena they investigate, their perspectives on the underlying theory of communication are very different [24]. One semiotic interpretation of the Shannon-Weaver communication model was proposed by Jakobson [25]. This model consists of six related elements: context, sender, receiver, message, code, and channel. The sender and receiver may alternate their roles, and the message has a context.

Adopting Jakobson's semiotic interpretations of the Shannon-Weaver communication model [24] might be useful when applying information visualisation in service delivery process description. Considering the six elements of the model might be beneficial for modelling of service delivery processes.

4) Modelling Languages

Modelling languages are artificial languages that show systems or information in a structure. A modelling language is composed of a description of its semantics and syntax [26]. Modelling languages define models that help us to understand how things are and how things behave. People model a language in order to communicate in a more effective and accurate manner and to exchange messages quickly and precisely without extraneous information.

A domain specific language (DSL) is defined as a tailored language for particular application domain [27]. DSLs have evolved based on the needs for more effective communication among people in specific domains. The London metro map, which was pioneered by Beck in 1931 [28], is a good example of DSL. Compared to general purpose languages, DSLs offer improved expressiveness and ease of use [27].

A domain specific modelling language (DSML) allows description of models in a specific area. Thus, a good DSML can support better cooperation in that specific area.

Developing a DSML might be a good solution for describing service delivery processes in order to support cooperation in service design. In addition, the DSML would support understanding information in service delivery processes and facilitate communication among the individuals involved in service design.

B. Process Modelling Languages

In this subsection, we present several depictions of a service delivery process created using some existing modelling languages in BPM. The applied languages are process modelling languages focused on representing the sequence of steps in BPM.

We used a referral process as an example to examine different techniques. There are essentially two types of referrals in Norway: external and internal. An external referral indicates a referral from a primary care provider (general practitioner, GP) to a secondary care provider (specialist). An internal referral indicates a referral from a department in a hospital in which a patient is admitted to another department in the same hospital or to another hospital in the same health region.

In our case study, we focused on the external referral process. The general activities of an external referral process in Norway are as follows. First, a patient referral letter (in paper or electronic form) from a GP is received in a hospital. Second, the letter is assessed by a medical expert. Third, depending on the result of the assessment, the patient gets an appointment with a specialist or is required to wait. Finally, the patient receives treatment, and the specialist sends an epicrisis, which is an analytical summary of a medical case history, to the GP who sent the referral letter. However, the referral process may vary among clinics, hospitals and regions.

In this subsection, an example of the initial part of an external referral process to an outpatient clinic in a Norwegian hospital is described using different process modelling languages. The details of our case study are described in Section IV. A.

Our example begins with a post document centre forwarding a referral letter. A specialist then screens the referral and, if another specialist group needs to assess the referral, returns it to the post document centre. Otherwise, the specialist assesses the referral. Depending on the content of the referral and the patient case history, the specialist assesses whether the patient needs prioritised medical assistance. If so, a nurse arranges an appointment for the patient. If not, the information is stored in an electronic health record (EHR) system for later scheduling.

1) Flowchart

The first process modelling language that was examined is a flowchart, which is a type of diagram that describes a process or workflow. The steps of the process are illustrated with various shapes and arrows that constitute the sequence of activities. Flowcharts are used in various fields to analyse, design, document or manage a process or program [29].

Figure 2 shows a basic flowchart describing the initial part of the previously mentioned referral process. The rounded rectangle on the top indicates the start of the process. The rectangle boxes indicate activities. The diamonds indicate decision points, and the arrows show the activity flow.
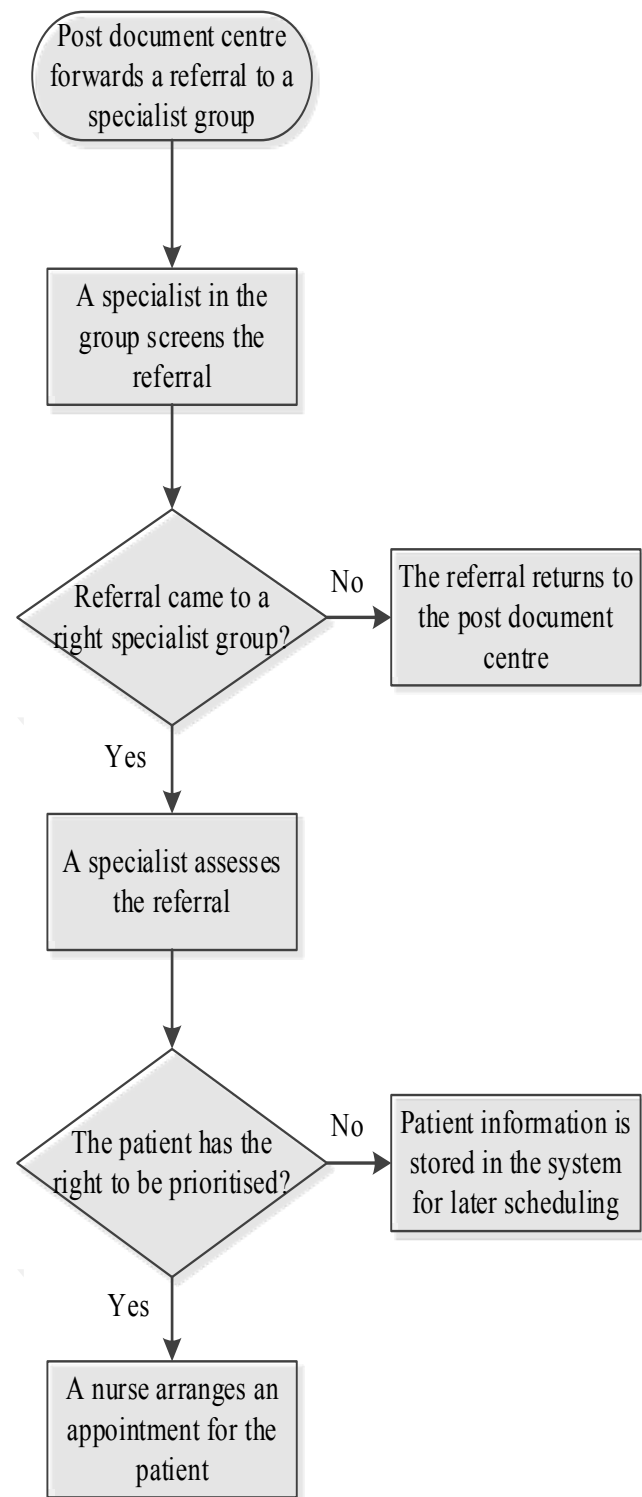

Figure 2. An initial part of a referral process illustrated by a basic flowchart

2) *Unified Modelling Language Swimlane Activity Diagram*

Unified Modelling Language (UML) is defined as 'a graphical language for visualising, specifying, constructing, and documenting the artefacts of a software-intensive system' [30]. UML consists of visual notations and the rules for the use. It includes many types of diagrams, such as class diagrams, use case diagrams, activity diagrams, etc. Eriksson and Penker claimed that the most important UML diagram for business process modelling is the activity diagram [31].

UML swimlane activity diagram is a type of activity diagram that can divide activities by roles or locations. Figure 3 shows the initial part of the referral process (the same part as Figure 2), which is described using a role-based swimlane activity diagram. Each swimlane (column) shows a different role participating in the process. The black circle on the top indicates the starting point. The diamonds show the decision points. The rectangular boxes indicate the activities, and the arrows show the transition flow from one activity to another.
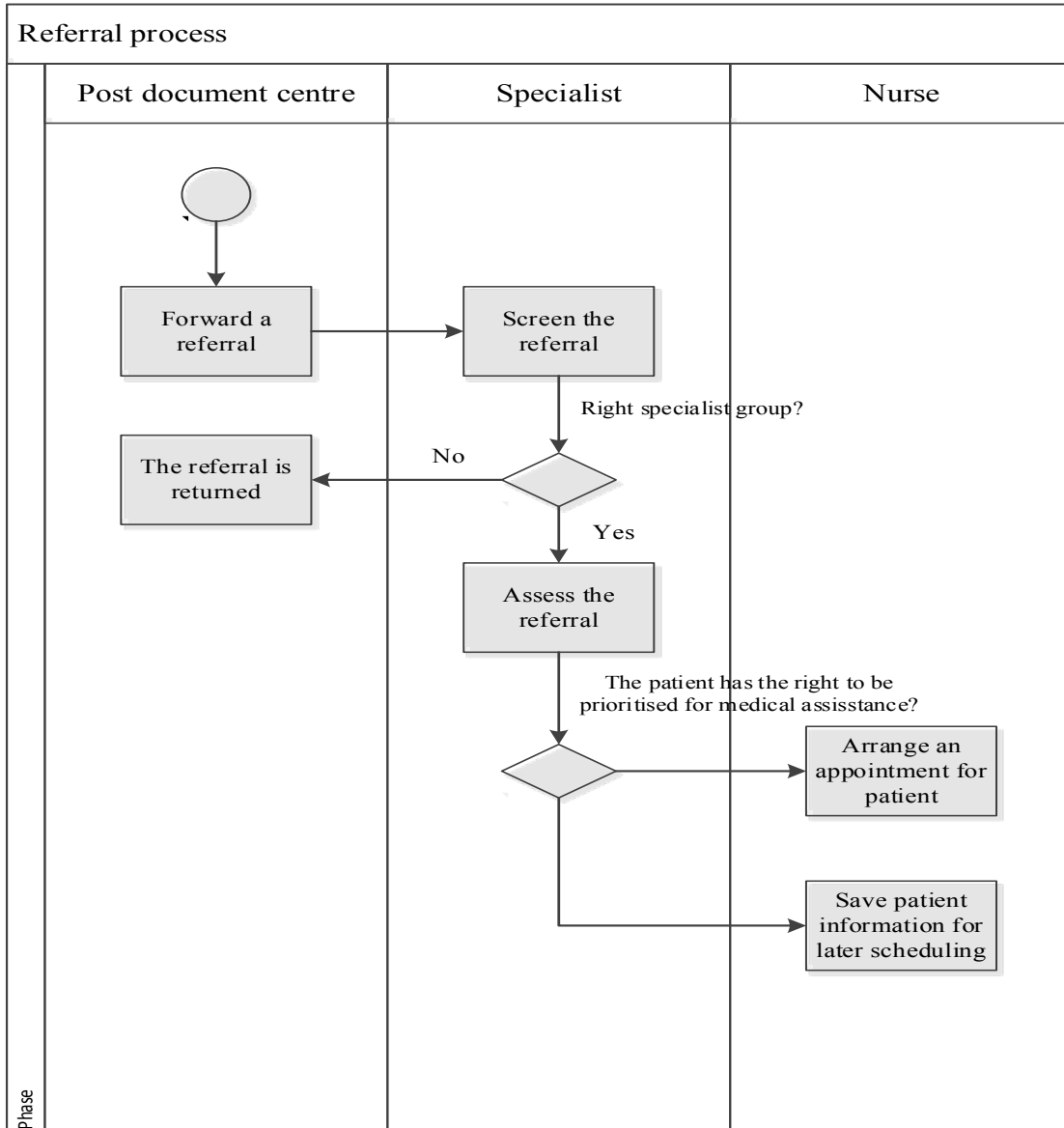

Figure 3. An initial part of a referral process described with a UML swimlane activity diagram.
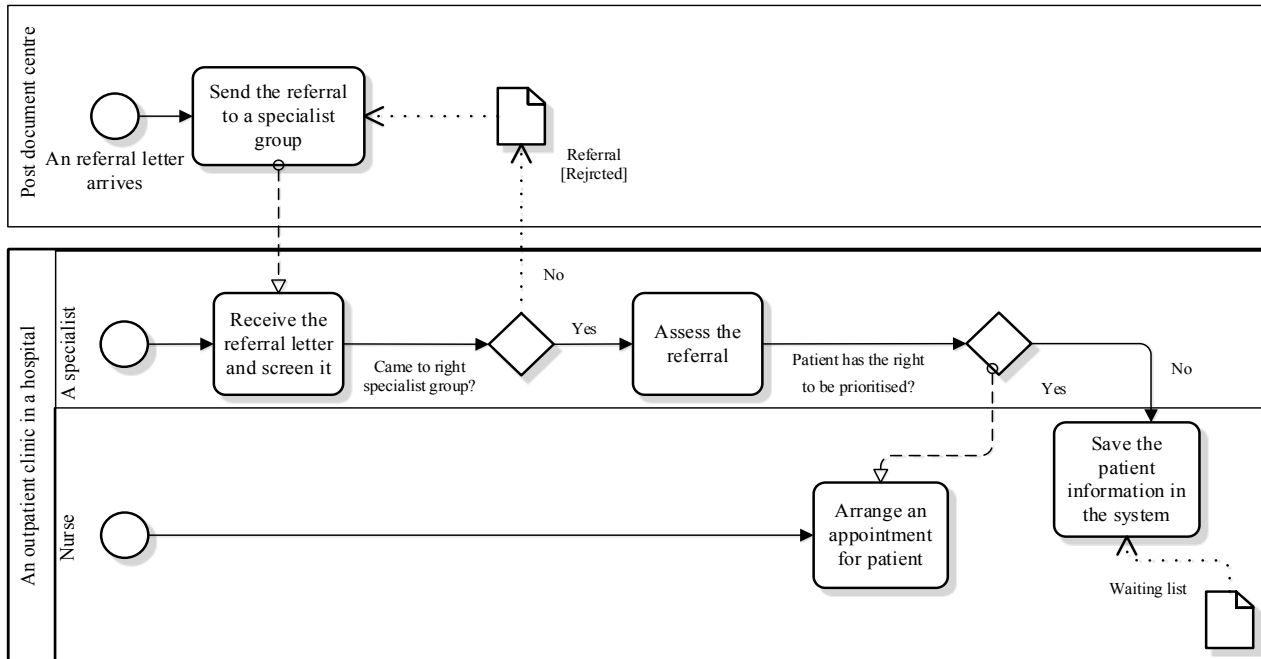
Figure 4. An initial part of a referral process illustrated by a BPMN diagram.

3) Business Process Modelling Notation

Business Process Modelling Notation (BPMN) is considered to be an 'understandable graphical notation for all business users', ranging from business analysts and technical developers to business managers, which can reduce the gap between business process design and process implementation [32]. It describes the steps in a business process using a flowchart that defines business process workflows [33].

Figure 4 shows an example of the use of BPMN for the initial part of the referral process. Similar to UML swimlane activity diagram, BPMN allows for description of the swimlane, activity, decision point, event, data object and pool, and provides three types of connectors: sequence flow, message flow, and association. However, BPMN takes a process-oriented approach while UML takes an object-oriented approach, and BPMN is designed to be more suitable for a business process domain so that it can better support BPM. In Figure 4, two locations are shown, the post document centre and the outpatient clinic in the hospital. In our example, there are two actors in the outpatient clinic: a nurse and specialist.

C. Technique in Service Design

In this subsection, we introduce a DSML equivalent service design technique that describes service delivery processes.

1) Service Blueprint

Service blueprint is a service design technique introduced by Shostack that has been widely used in service management and marketing [34]. It shows the series of service actions and the time flows that are related to the roles of the actors involved in a service delivery process.

The actions that customers take as part of the service delivery process are separated from the actions of the contact person by the line of interaction. The line of visibility differentiates the actions of an on-stage/visible contact person (actions that are seen by the customer) from the actions of a back-stage/invisible contact person (actions that are not seen by the customer). Support processes, which include all the activities carried out by individuals or units in the company that are not contact persons, are separated from the actions of the contact person by the line of internal interaction. Physical evidences refer the media that customers come in contact with when they perform their actions.

A service blueprint enables managers to have an overview of an entire process and provides useful information for the development and evaluation of new services [14]. Figure 5 shows the initial part of the referral process using the extended service blueprint introduced by Bitner et al. [14]. In Figure 5, the customer is a specialist in the hospital.
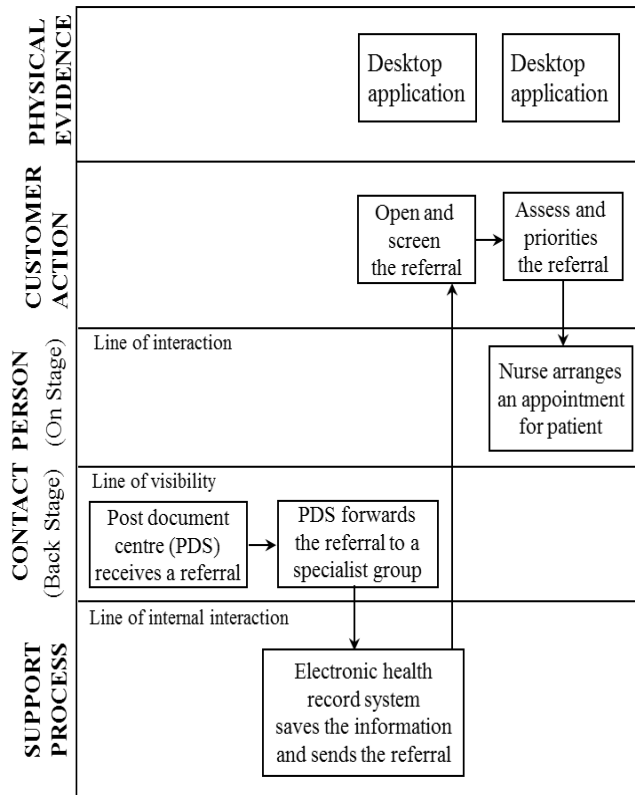
Figure 5. An initial part of a referral process drawn by a service blueprint

D. Summary

Flowcharts help us understand the overall processes [35], but the lack of visual notations to represent actors and their interactions might hinder the reader's ability to clearly understand the service delivery process. UML swimlane activity diagram shows the sequence of activities with clear role definitions [35], but it still does not have any visual differentiator for actions and interactions. BPMN is an industry standard for process modelling and has visual notations for event, data object and various types of connectors (sequence flow, message flow and association). Nevertheless, it supports no visual differentiator for actions and interactions. Recker et al. argued that BPMN still requires more symbols with extended expressiveness to add sufficient consistency for making the models fit for use [36]. Afrasiabi et al. claimed that there is a lack of standard graphical notation for business process modelling languages [37]. The same applies to service blueprint. There is no standard service blueprint with common terminology and visual language [38]. Therefore, to include more information about a service delivery process, the service blueprint format must improve its visualisation capacity [6].

Flowchart, UML swimlane diagram, and BPMN illustrate only the expected service delivery processes. They were developed to be used to prescribe planned processes. Service blueprint allows us to see the technical parts of the service delivery process that customers cannot see. However, it often only supports description of the expected service delivery processes, not the actually executed ones.

In addition, service blueprint does not take a network view of services. Service blueprint does not support describing complex service structures that involve relationships among actors and events [6]. UML swimlane activity diagram, and BPMN can support the description of networked interactions among actors, but flowchart and service blueprint might not be able to do so.

Table I summarises the different process modelling languages and the service design technique for BPM that have been described. The second column from the left indicates the purpose for using the language or technique. The third column indicates whether the language or technique considers a service providers' and/or customers' perspective. The fourth column indicates whether the language or technique supports the presentation of actually executed service delivery processes or the presentation of prescribed service delivery processes. The fifth column shows what kind of customer and service provider relationship the language or technique supports.

Flowchart is used to describe a sequence of interactions, while UML swimlane activity diagram is used to illustrate a sequence of interactions and data. BPMN is used to demonstrate a sequence of interactions and data for business purpose, and service blueprint is used to draw a sequence of interactions for service design. The presented languages and technique mainly consider the service providers' point of view. Flowchart, UML swimlane activity diagram, BPMN, and service blueprint can support the description of only the expected or prescribed execution of a service. UML swimlane activity diagram and BPMN can support the illustration of networked relationships among the customer, service provider, and third party, but flowchart and service blueprint support the illustration of the dyadic relationships.

Therefore, there is a need for a process modelling language that includes service providers' and customers' perspectives, and can support the presentation of the actual execution of a service and the networked relationships among actors. A service domain specific process modelling language that satisfies these aspects will be introduced in Section III. This process modelling language was designed to address the weaknesses of the existing languages and technique by adopting information visualisation and communication theory. Thus, it aims to show the interactions among different actors in an easily understandable manner. In addition, the language was designed to have a rich enough graphical capacity to properly illustrate the service delivery process.

TABLE I. PROCESS MODELLING LANGUAGES AND SERVICE BLUEPRINT

Language/technique	Purpose of the use	Perspective of the presentation	Presentation type	Customer and service provider relationship
Flowchart	Sequencing of interactions	Service provider–oriented	Prescriptive	Dyadic relationship
UML swimlane activity diagram	Sequencing of interactions and data	Service provider–oriented	Prescriptive	Networked relationship
BPMN	Sequencing of interactions and data for business purpose	Service provider–oriented	Prescriptive	Networked relationship
Service blueprint	Sequencing of interactions for service design	Service provider–oriented (back-stage oriented)	Mainly prescriptive	Dyadic relationship

III. SETTING THE SCENE: REQUIREMENTS AND EARLY VERSIONS OF THE SERVICE JOURNEY MODELLING LANGUAGE

This section presents our first steps in developing the modelling language. Subsection A describes the overall requirements and the development procedure, and subsection B describes the elements of SJML v1.0. Subsection C describes the initial feedback on SJML v1.0 while subsection D briefly describes SJML v1.1.

A. Overall Requirements and Development Process

We wanted to develop a language that supports specification, description and analysis of the service delivery processes for service design, as described in Section II.A. Our language is based on a customer journey mapping approach, which is introduced below.

Customer journey maps (CJM) are widely used in service design to visualise service delivery processes from the end user's perspective. CJM allows description of the details of service interactions and associated emotions in a highly accessible manner [13]. CJM is often structured around touchpoints and is confined to a certain period of time. A touchpoint corresponds to an interaction between a customer and a service provider, but may also denote a communication channel between the customer and service provider. CJM is one of the most commonly used visualisation techniques within service design, where it utilised to obtain an overview of the customer's service consuming process. It communicates customer insight [39], which in turn can be used to identify problem areas and opportunities for innovation [13]. Using CJM, one can easily compare a service with its competitors [13].

We expanded the concept of CJM by addressing the requirements that are explained in the next paragraph. The research was conducted according to the design science's three phases (problem analysis, solution design, and evaluation) in an iterative manner to create artefacts, the language and knowledge in the research domain.

The language we developed was designed to:
- Strengthen customer orientation and facilitate collaboration among all actors through a common vocabulary and extensive use of visualisation
- Support service design and development by means of a precise language for specifying actors, interactions among them, the timing of their interactions, and the communication channels used
- Support the analysis of services to check consistency; in particular, it facilitates the monitoring of service execution by comparing it to the expected or prescribed service delivery process

Table II provides an overview of the versions of SJML. The first column on the left shows the version. The second column presents the elements of the version. The third column describes the type of the study conducted for evaluation and further development. The fourth column shows whether the version was evaluated with existing or new services. The fifth column presents the degree of complexity of the service(s) it portrayed. The sixth column shows the place(s) where the version is described.

A touchpoint is a point of interaction between a customer and a service provider, and it is a central element of our language. SJML v1.0 consisted of basic elements (touchpoint, channel, actor, and status) to describe a sequence of touchpoints for expected journeys (sequential view). SJML v1.1 added new diagram elements and a diagram type. Visual notations for action, decision point, concurrency, and un-ordered sequence were added, and a deviation view was introduced to describe the actual journey. SJML v2.0 added additional diagram elements and adjusted some elements. Diagram elements for system activity, touchpoint description, and time flow were added, and visual notations for touchpoint, action, actor, initiator, and recipient were modified. A new diagram type (swimlane view) was introduced to illustrate the service journeys of several actors to support the description of a networked perspective of the service journeys. The evaluations were performed by describing services using the three versions of our language. The earliest version of the language was evaluated by describing simple services (book loan services at a library). The results are described in the original paper [1]. More complicated services (customer enrolment services) from our research partner companies were described using SJML v1.1, and the findings were reported in a conference paper [8]. SJML v2.0 was developed and evaluated by describing an even more complicated service (a healthcare service) that involves many actors and the interactions among them. The results and findings are described in Section IV.

TABLE II. CHARACTERISTICS OF THE DIFFERENT VERSIONS OF SJML

Version	Language composition	Evaluation			Described in
		Type of study	Service type	Complexity	
SJML v1.0	*Basic attributes that form a basic diagram type* Basic diagram elements (touchpoint, channel, actor, and status) supporting description of a basic diagram type (sequential view)	Preliminary experience with library services	Existing service and new service	Simple service	[1] and Section III. of this paper
SJML v1.1	*SJML v1.0, additional attributes, and a new diagram type* New diagram elements (action, decision point, concurrency notation, and un-ordered sequence) and a new diagram type (deviation view) were added in SJML v1.0	Two case studies with customer enrolment services	Existing services	More complicated service	[8] and Section III.D. of this paper
SJML v2.0	*Adjusted and additional attributes, and a new diagram type* Adjusted elements (touchpoint, action, actor, initiator, and recipient), new diagram elements (system activity, touchpoint description, and time flow), and a new diagram type (swimlane view)	A case study with a referral process in healthcare service	Existing service	Even more complicated service	Section IV. of this paper

B. Service Journey Modelling Language v1.0

The first version of SJML (SJML v1.0) consisted of terminology, symbols, graphical elements, visual syntax, and visualisation modes. As this subsection represents the first phase of our research, we wanted to investigate the needs of practitioners when designing new services or improving existing services; what information about customers and their interactions in the service journey is essential to be monitored to align business processes with customers' needs.

Each touchpoint has a symbol inside a circle. The symbol shows a channel or device that is used for the touchpoint. The colour of a touchpoint's boundary indicates the actor who initiates the touchpoint. The boundary style specifies the status of the touchpoint. The elements for SJML v1.0 are detailed below.

- **Touchpoint.** Service journey consists of touchpoints that are described with circles.
- **Channel.** Each touchpoint has a symbol inside a circle. The symbol shows a channel or device that is used for the touchpoint.
- **Actor.** The colour of the touchpoint's boundary indicates the actor who initiates the touchpoint.
- **Status.** The boundary style indicates the execution status of the touchpoint (solid boundary: completed, dashed boundary: missing, and crossed touchpoint: failed).

C. Evaluation of SJML v1.0

To obtain initial feedback on SJML v1.0, we organised a half-day workshop with library staff. The purpose was to investigate SJML v1.0's feasibility and collect requirements for further development. The workshop was arranged for June 2013 as a service design seminar on the premises of the science library at the University of Oslo. It consisted of a lecture about service design and two practical sessions. SJML was presented and evaluated during one session.

The researchers collected data through participatory observation and a plenary discussion. Thematic coding [40] was used to analyse the field notes of the researchers and summarise the results.

The SJML session included a short introduction to the relevant terminology and visual notations, and a presentation of the various exercises to be performed by the participants. Twenty-six individuals participated. Seventeen were library employees, four were students, and five were researchers. The session lasted about 30 minutes and concluded with a group discussion.

Participants were divided into four groups and were asked to construct a customer's service journey of borrowing a paper or an electronic book at the library. One blank circle plus seventeen book-loan service-relevant symbols, which were selected from 32 SJML symbols, were given to each group as a set (Figure 6).
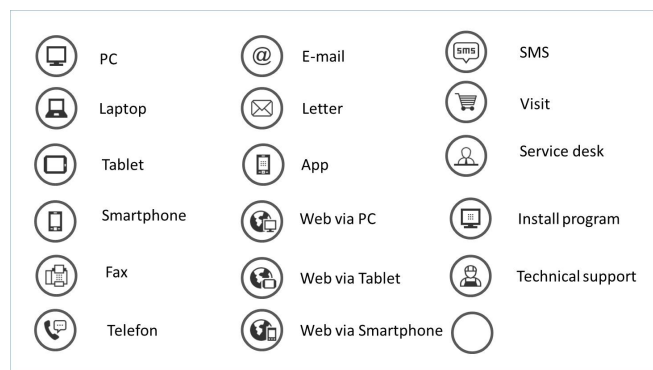
Figure 6. SJML symbols given at the workshop

In this workshop, we observed the use of the touchpoints. Pen and paper were provided to the groups in order to allow them to draw the sequence of the touchpoints. The members of the groups were allowed to create their own touchpoint with the blank circle in the event they do not find the touchpoint they needed. The actor and status attributes of a touchpoint were not adopted for this session.

The first task was to construct the customer journey for borrowing a paper/electronic book (Figure 7). The process of borrowing a book included extension of the loan and finished when the book was returned. The second task was to construct the customer journey for ordering a paper/electronic book that the library did not have. The process included extension of the loan and finished when the book was returned. Participants were asked to make customer journeys for both existing (Figure 7) and desired book loan services.
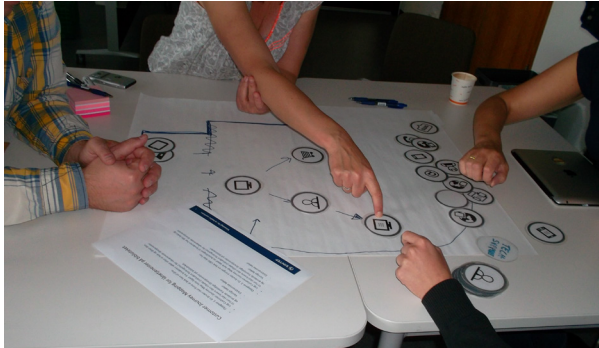

Figure 7. Participants are on the process of making service journeys for an existing book loan service (borrowing of an electronic book)

Results

We observed that the participants did not have any problems understanding SJML and using its symbols. Participants were able to construct and explain their service journeys using SJML. However, some participants were confused about using symbols that looked similar to each other, such as the symbols representing PC and web access via PC. During the feedback discussion, it became evident that the participants missed certain functionalities as directing the flow of the process through conditional gateways or decision points that occur repeatedly during such services. It was also found that more icons would be needed to illustrate the library services more precisely.

D. Service Journey Modelling Language v1.1

Based on the initial feedback on SJML v1.0 and the requirements that were subsequently discovered, we extended the language. Action was added as one of the main elements along with touchpoint, and more touchpoint attributes were added. SJML v1.1's detailed description and our experience with the language can be found in [8]. The elements for SJML v1.1 are detailed below.

- **Touchpoint, channel, actor,** and **status** are the same as in SJML v1.0.
- **Action.** A service journey consists of touchpoints and actions. An action is an event or activity conducted by a customer or service provider as part of a customer

journey. Unlike a touchpoint, an action does not include any form of communication between the customer, the service provider or a third party.

- **Decision point.** A decision point refers to an expected customer journey being split into 'sub-journeys'. It is illustrated using a square diamond.
- **Concurrency.** In some situations, a touchpoint occurs at the same time as another touchpoint. We call this concurrency and describe it with two separated half-dotted circles. A visual indicator (two clocks and a wave symbol) was introduced to represent the space between the two half-dotted touchpoints.
- **Unordered sequences.** Brackets were introduced to describe unordered sequences of touchpoints.

IV. ADDING COMPLEXITY: FURTHER DEVELOPMENT OF THE LANGUAGE

We wanted our language to be able to describe complex service journeys. Thus, SJML v1.1 was updated to present many actors and their interactions by adapting the swimlane approach. This section describes the use of SJML v2.0 for modelling complex service delivery processes and our experience with it in a hospital case.

A. Case Study with Patient Referral Processes

To identify a set of requirements for a visual language related to modelling the processes of complex services, we conducted a case study involving the modelling of referral processes in health care services. We collected data regarding the referral process from a Norwegian hospital during the autumn of 2013 and used SJML to model the various aspects of the processes.

Due to the number of actors involved, interactions among them, and the number of steps in the process, the referral process is regarded as one of the most complicated services [41]. A referral process is a highly complex process because it often involves many actors (e.g., a patient, a healthcare provider who sent the referral like a GP, administrative personnel such as a receptionist, nurses and medical experts at the receiving facility) and their tasks are interrelated across different organisations, such as a GP's office and a hospital.

The external referral process in the Norwegian hospital where we collected data consists of the following steps: a health secretary receives referral letters and sorts them; a medical expert assesses the referral and makes a decision; a nurse or health secretary follows up the referral, sets a time for a patient visit and notifies the patient; the medical expert meets the patient; and the medical expert communicates with the healthcare provider who referred the patient. Patient-administrative systems are central to the referral process, and the EHR system is one of the core patient-administrative systems used by the healthcare personnel.

B. Data Collection

To understand how the referral process works and what it consists of in practice, we visited a surgical outpatient clinic at a hospital in Norway three times during September and October of 2013. We collected data using observations and semi-structured interviews during our visits. A researcher wrote down field notes during the observations and the interviews with administrative personnel, nurses, and medical experts. We also studied an E-learning's module, documentation, and photos that are relevant to the referral process. The detailed data collection procedure is introduced below.

We first studied the hospital procedures and routines concerning referrals in general using an E-learning module for the EHR system. We then classified the procedures. After that, actual data from the referral processes were collected through observations. These data consisted of three detailed patient histories that were extracted from the EHR system. Photographs of screenshots were taken during the observations. Then, the data were supplemented by semi-structured interviews with a nurse, a medical specialist, and a health secretary. The interviews were audio-recorded. Relevant documents such as patient brochures and documentation explaining the referral process and internal routines were also obtained. In addition, we had telephone meetings with a nurse and asked her for some additional explanations via email.

C. Data Analysis and Further Development of SJML

Reconstruction of the three patient cases formed the core of our analysis. The three patient histories were reconstructed by combining the patient journal with the referral module in the EHR system. A chief nurse anonymised the data from the patient journal and assisted in constructing the patient histories. To process the fragmented data from the interviews and the EHR system, each patient history was compiled and systemised using a preformatted spreadsheet template. The patient histories were organised by date, physical location, and events, and attributes such as initiator, recipient, task description, and communication channel were specified.

The results from the data analyses were used to describe the referral processes using SJML v1.1. We organised workshops in which three researchers sketched different approaches for visualising fragments of the referral process through trial, error, and exploration. When visualising the referral processes, we could also identify requirements for the further development of our visual language. We improved our language on the basis of the requirements through several iterations. Those requirements and our solutions are described as following.

(1) *Ability to visually describe and distinguish among several actors in a more appropriate way*

Using different colours to distinguish among actors might not be suitable in case many actors are involved. Thus, we needed a new way to describe several actors. Alternative representations were explored through trial and evaluation of various solutions. Finally, swimlanes with actor icons and titles were adopted. This approach seems applicable to account for all the actors involved.

(2) *Ability to describe and distinguish each actor's touchpoints that connect the actors*

Since we adopted the swimlane approach, there was a need for a new way to describe touchpoints that involved communication among actors. The language should therefore have touchpoints for both the initiator and recipient. We adopted a sender-recipient concept. Each touchpoint was duplicated and placed in both the initiator's and recipient's swimlane so the readers could recognise each actor's journey easily by following each swimlane. The boundary colour of a touchpoint showed if the touchpoint was sent or received by the actor.

(3) *Ability to distinguish among touchpoints mediated by the same channel, and thus having the same symbols*

Sometimes, several touchpoints occur through the same communication channel. For instance, a customer may receive two SMS messages from the service provider. We proposed a text area to allow for a detailed annotation of the touchpoint. The textual explanation, together with a symbol of the channel inside a touchpoint square box, would facilitate a detailed understanding of the touchpoint.

(4) *Ability to describe dataflow in the EHR system*

Some information is delivered from sender to receiver through the EHR system, such as when updating and saving information. Therefore, we needed a way to describe dataflow in the EHR system. We proposed adding the EHR system as an actor and using arrows to illustrate dataflow.

(5) *Ability to distinguish between the workflow of referral and dataflow*

Since we used an arrow for both workflow and dataflow, we needed a way to distinguish between these two types of flow. We proposed using differently shaped arrows for workflow and dataflow. Normal black arrows were adopted to describe workflow while dotted arrows were adopted to describe dataflow.

D. Components for Visualisation

Figure 8 shows SJML v2.0 representing process steps in the form of touchpoint or action. The text area enables annotation concerning the context of the process step. In SJML v2.0, a box was used to represent touchpoints and actions as its shape can contain text more economically than a circle. The colour of the touchpoint boundary indicates the initiator (blue) and recipient (green), and a symbol area carries information about the channel or device mediating the touchpoint. In contrast to touchpoints, actions have no sender or recipient, thus they do not need a colour to distinguish between sender and recipient, nor a symbol to represent the communication channel.
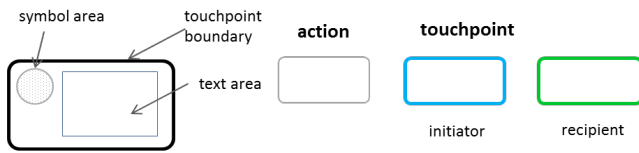

Figure 8. Visual components for our expanded language

Figure 9 presents an excerpt of SJML v2.0, showing two touchpoints in a patient's journey. On the left is a symbol representing the patient along with a text label. The first touchpoint represents an interaction in which the patient receives a phone call from the hospital (a common procedure when scheduling an urgent appointment). The next touchpoint shows an interaction in which the patient receives the appointment letter with all necessary details about the imminent consultation and a brochure regarding patient rights. Here, the patient is the recipient of both touchpoints, signalled by the green colour. Correspondingly,

the health secretary responsible for the telephone call and the letter is the initiator of both touchpoints. The corresponding touchpoints of the health secretary would appear with blue-coloured boxes in a separate swimlane.
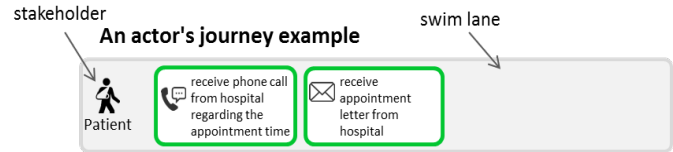

Figure 9. A part of a patient's journey

E. Mapping in a Real Context

Figure 10 shows a part of the real referral process described using SJML v2.0. Arrows indicate the workflow and dataflow. Black arrows represent the workflow in the process while grey dotted arrows represent the dataflow to/from the EHR system. Time flow with time stamps is shown by the black line on the bottom. This example is based on one of the real patient histories explained in subsection D.

First, a GP transferred an electronic referral letter to a hospital for a patient with a lipoma who visited him/her. Second, a health secretary in the document centre of the hospital received, registered and forwarded the referral to a specialist in the hospital. Third, the specialist assessed the received referral and forwarded it to a health secretary in the clinic for follow-up. Fourth, the health secretary checked the received referral and sent a standby letter to the patient, and so on. The entire version of this referral process can be found in Appendix A.
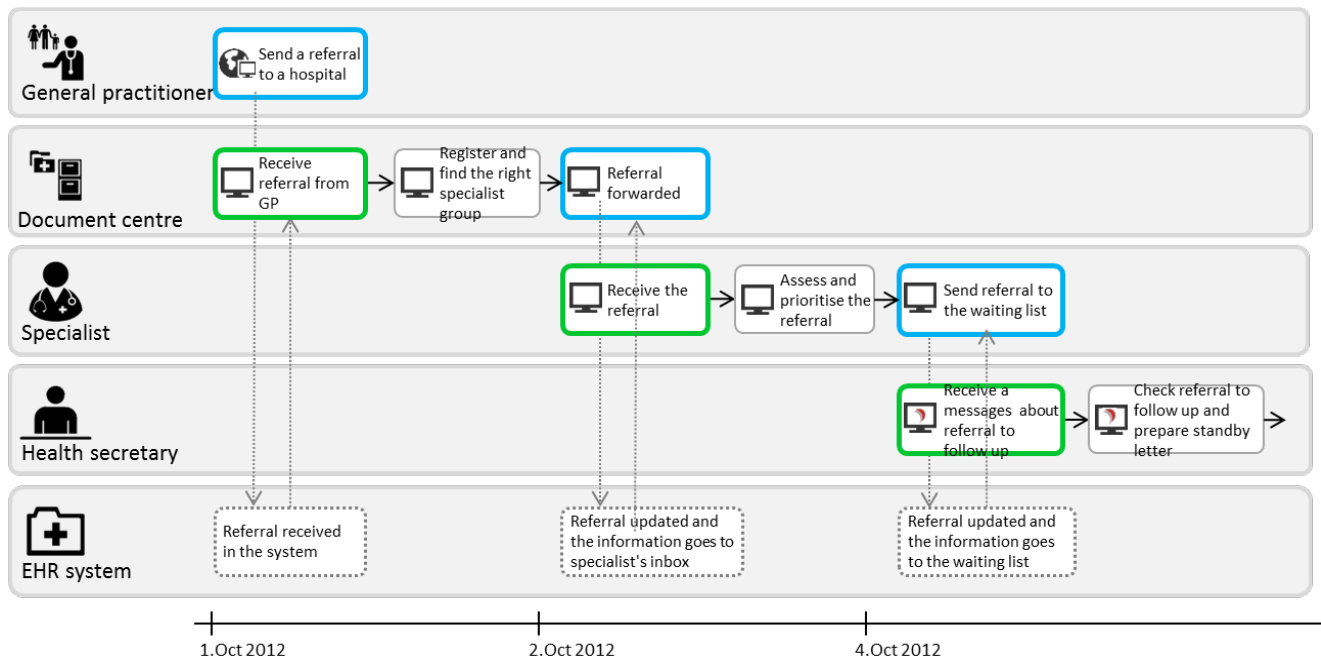

Figure 10. The result of the proposal for extension of the language

F. Service Journey Modelling Language v2.0

SJML v2.0 consists of a sequence of touchpoints, actions, and system activities. The elements of SJML v2.0 are detailed below.

- **Touchpoint.** A touchpoint indicates a point of interaction between two actors. The shape of the touchpoint was changed from a circle to a rounded rectangle since more space was needed for text to add information concerning the touchpoint.
- **Action.** An action indicates an event performed by an actor as part of a customer's journey. It is represented by a rounded grey rectangle.
- **System activity.** This is an activity performed by the EHR system. It is represented by a dotted grey rectangle.

Attributes of touchpoints, including channel, status, initiator, and receiver, and touchpoint description were specified for SJML v2.0.

- **Channel.** The symbol area for channel has been moved to the upper left of a rounded rectangle touchpoint.
- **Status.** The way to describe the status of a touchpoint is the same as in SJML v1.0 and v1.1.
- **Initiator and recipient.** Initiator (rounded rectangle with blue-coloured boundary) indicates an actor who initiates the touchpoint, and recipient (rounded rectangle with green-coloured boundary) indicates an actor who receives the touchpoint. We found through the case study that there could be more than one recipient of a touchpoint in some cases.
- **Touchpoint description.** A text area has been added on the right side of the rectangle to describe the touchpoint in detail.

Graphical notations have been modified for SJML v2.0. The swimlane approach was adapted to present several actors. Therefore, the way of presenting actors has been updated. One can see each actor's journey by following each swimlane. An axis with time information for each touchpoint has been added to show the time flow of the service journey.

- **Swimlanes.** The swimlane concept was adapted to describe the service journeys of several actors. Touchpoints, actions, and system activities for an actor are allocated inside a horizontal grey bar. Several bars are collocated vertically, and the interactions are described with arrows and the colours and descriptions of the touchpoints.

- **Actor.** The boundary between customer and service provider has become ambiguous due to the involvement of many actors. All of them are actually customers of the EHR system. A symbol on the left side of a swimlane bar represents an actor. The text below the symbol specifies the role of the actor in the service journey.
- **Actor's journey.** An actor's journey can be seen by following a swimlane bar.
- **Time flow.** An axis with time stamps under the swimlane diagram represents the time flow and the occurrence dates of the touchpoints.

G. Preliminary Experience

We verified the visualisation of the referral process using SJML v2.0 by communicating with the chief nurse via emails and telephone conversation. We then presented the visualisation to a small group of experts (five employees) who work at the eHealth system producing company that produces the EHR system through a remote workshop using Lync. After the presentation, a set of questions was sent to the participants via email to collect preliminary feedback. The questions investigated whether the referral process and visual elements described using SJML v2.0 were understandable and whether the language would be helpful for creating a common understanding of the business process or workflow of the referral process. We received answers from two respondents. Thus, we have only anecdotal evidence of evaluation of the language based on this preliminary experience. The preliminary feedback from the participants regarding SJML v2.0 was analysed and summarised using thematic coding [40]. The summary is presented below.

Description of the process and visual elements using SJML v2.0:

- The language itself is relatively easy to understand
- The swimlanes to distinguish actors are simple, straightforward and easy to understand
- The symbols for actors and channels are easily understandable
- The use of different colours to distinguish the initiator and receiver is helpful for identifying the initiator

Creating a common understanding of the process and workflow using SJMLv2.0:

- The representations of SJML v.2.0 are suitable for discussing and establish a common understanding of the workflow and relationships among actors
- It would be better if the tool could also illustrate alternatives in a process.

V.   DISCUSSION

Through our analysis of the related work, we found some weaknesses in the existing process modelling languages and the service design technique describing service delivery processes. First, there is a need to focus on the customer's perspective [1]. Second, there is a need to support the satisfactory description of the actual execution of the service delivery process [5][6]. Third, there is a need to sufficiently illustrate networked relationships in the service delivery process [7]. Fourth, there is a need for better visual expressiveness to describe the service delivery process explicitly [5][6][37]. Thus, there is a need for a new language or technique.

Relevant knowledge in the areas of service design, information visualisation, communication theory, and modelling languages have formed a theoretical basis for our approach to find a solution for these needs. Based on this approach, we developed a service domain specific process modelling language (Service Journey Modelling Language, SJML) to cover the aforementioned gaps in BPM for services. The language was developed and evaluated through case studies with partner companies, following the three phases of design science (problem analysis, solution design, and evaluation) in an iterative manner. For evaluations, we used each version of our language to describe existing or new services.

We evaluated the first version of our language (SJML v1.0) through a workshop with library staff by describing simple service journeys (book-loan services in a library) [1]. During the workshop we found that the participants did not have any problems in understanding SJML v1.0, and they could construct service journeys with our language. Feedback from the participants indicating the weakness of SJML v1.0 (a need for decisions points) was addressed when we developed the next version of our language (SJLM v1.1). SJML v1.1 was evaluated by describing more complicated service journeys from our research partner companies [8].

SJML v1.1 was updated by describing an even more complicated service journey (a referral process), which presents many actors and their interactions. The updated version of our language (SJML v2.0) adopted a sender-recipient concept and a swimlane approach. We visualised a patient history that was extracted from an EHR system using SJML v2.0 and presented the result to a small group of people via a remote workshop. We received feedback from the participants that the visual elements and the language itself were easy to understand and suitable for creating a common understanding of the workflow and relationships among actors involved in the business process.

To represent the customer's perspective, our language was developed based on a customer journey mapping approach that introduced the touchpoint concept. SJML v1.0 supported a sequential view to describe the expected journey. To support the description of the actual journey, SJML v1.1 added a deviation view. SJML v2.0 added a new diagram type (swimlane view) to support the illustration of the networked relationships of several actors in a service delivery process. Each version of SJML expanded the graphical elements to better support the visual expressiveness.

VI.   LIMITATIONS

The library service and referral process can vary in practice, depending on the organisation. In this paper, we conducted our case studies on book loan services in a Norwegian university library and a referral process in a Norwegian hospital; thus, SJML might not meet all the challenges necessary to describe similar services in other organisations.

For the case study on the referral process, we collected patient data based on existing patient care histories in an EHR system. Therefore, there might be a limitation in regards to covering all the touchpoints or actions that were not registered in the EHR system.

The initial feedback on SJML v1.0 was gathered through observations and a group discussion. Audio recordings were not used, and thus the discussion was not transcribed. Observers took notes when the group members talked, and the results were based on those field notes. Therefore, the descriptive and interpretive validity might be limited.

VII.   CONCLUSION AND FUTURE WORK

Services usually have complex structures with several actors whose interests are intertwined. Aligning business processes with the customer's perspective is important for BPM, especially in the service field. To do this, a good understanding of interactions among the actors involved in service provision and consumption is needed. Several techniques for managing business processes to support the service delivery process were suggested in the context of process modelling and service design. However, there was a lack of support for describing the customer's point of view, the actual execution of service and the networked perspective of the service delivery process. In addition, there is a need to improve the visual expressiveness of the existing techniques.

Several versions of SJML were developed and evaluated in an iterative manner to strengthen the customer orientation, to facilitate collaboration among all involved actors and to support specification, description and analyses of service delivery processes. The requirements gathered from the evaluations provided useful input for further development of our language.

We believe that SJML v1.0 supplements BPM for services by aligning business processes with the customer's perspective [1]. SJML v2.0 supports the description of the actual journeys of actors and their networked interactions. Therefore, we expect that SJML will support BPM of complex services. Furthermore, the results from our preliminary experience support the contention that the visual representations of our language could be effective in creating

a common understanding of workflows and relationships among various actors in the business processes of services.

We intend to investigate the usefulness of SJML in BPM in future studies. Experiments or another case study with a larger number of participants would be used in further research.
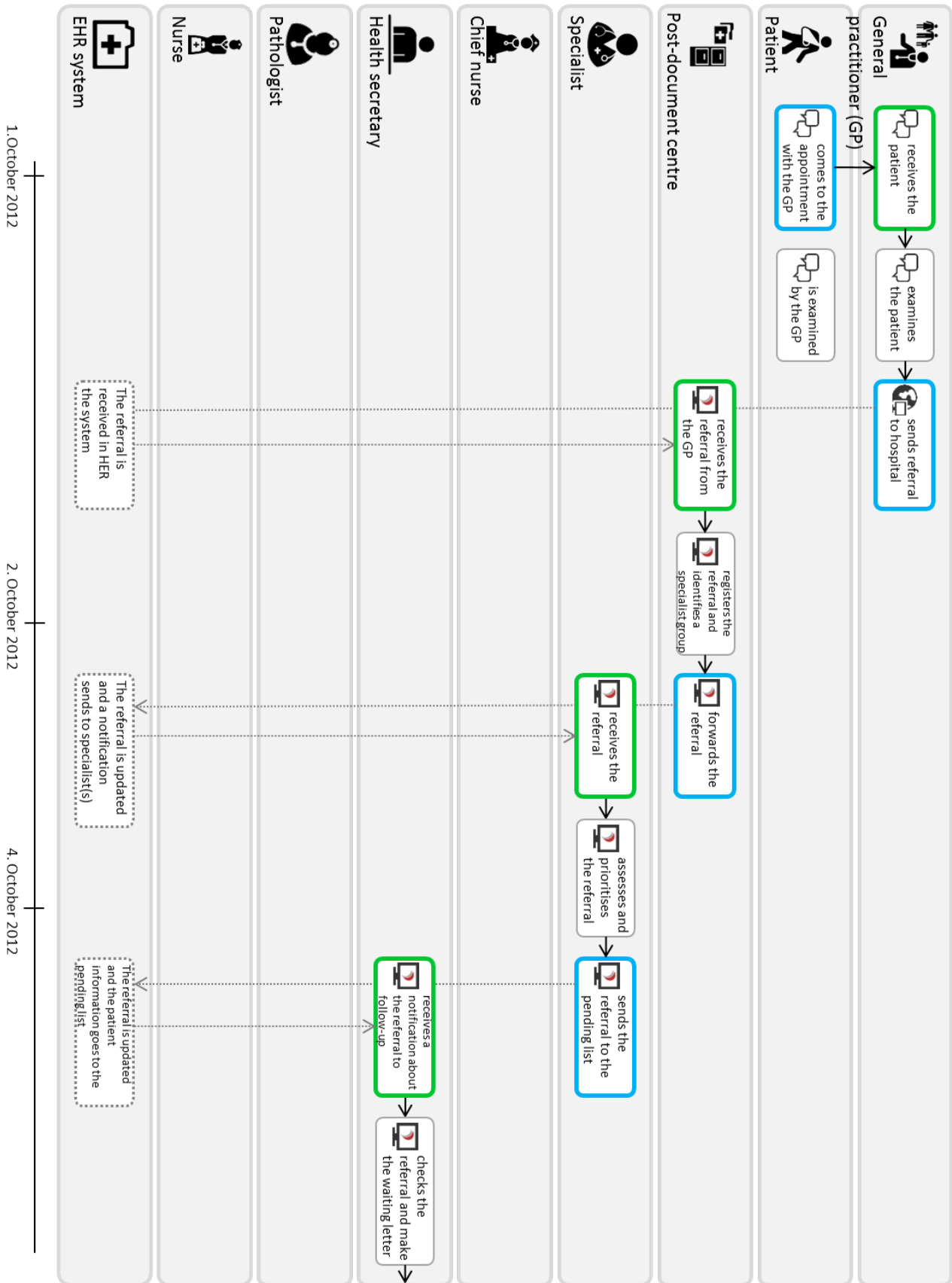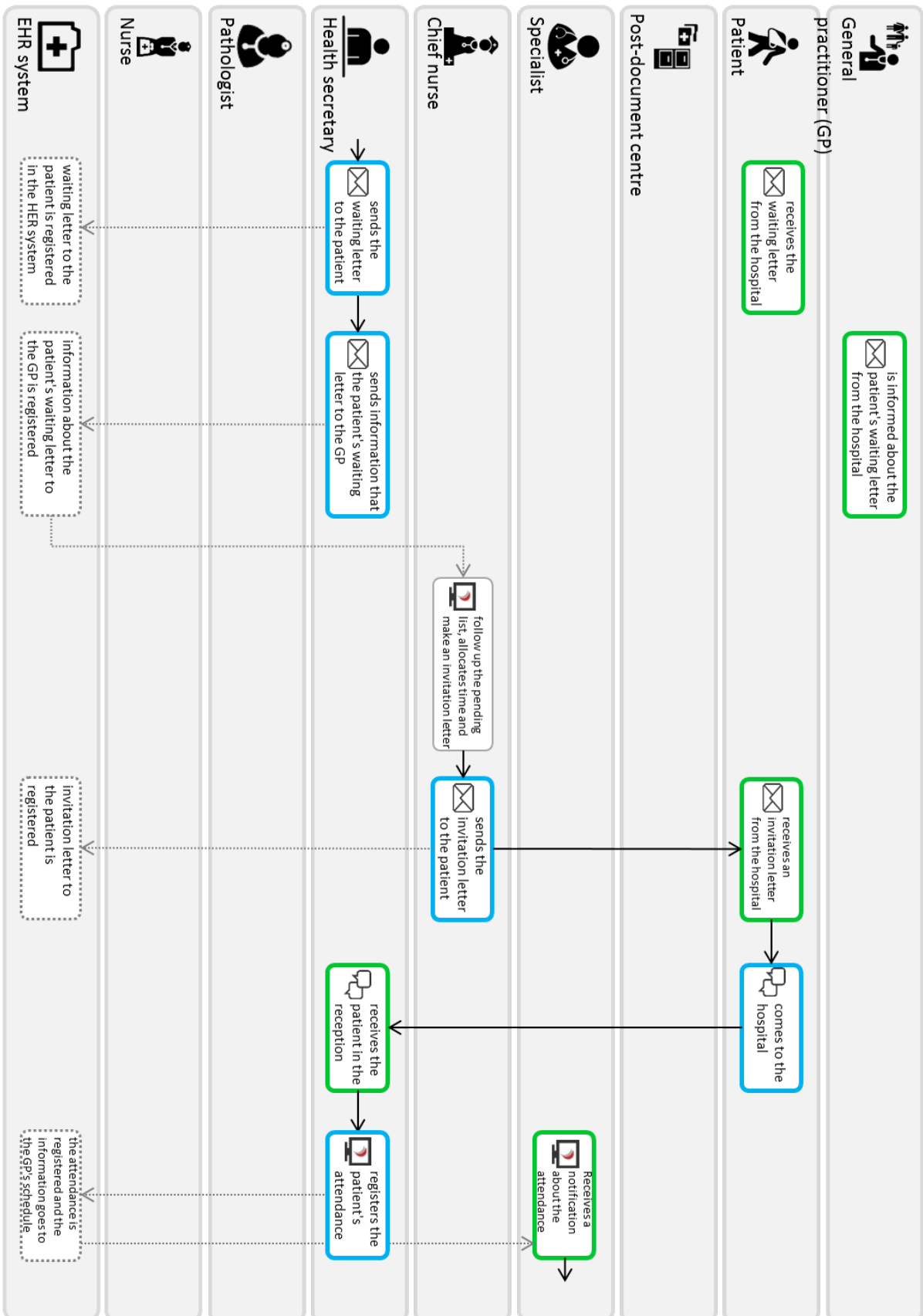
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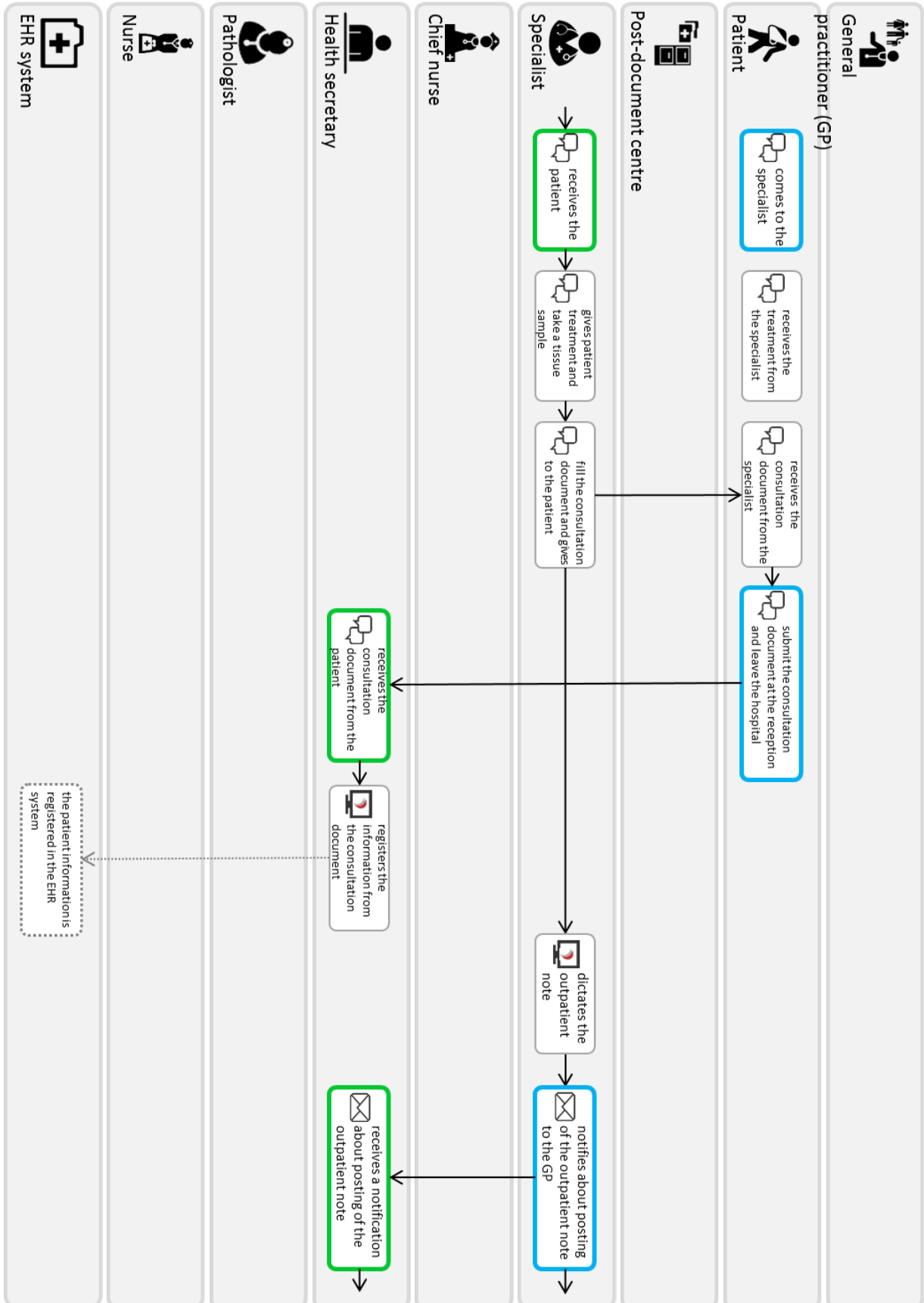[26]   D. Harel and B. Rumpe, "Meaningful modeling: What's the semantics of 'Semantics'?," The IEEE Computer Society,

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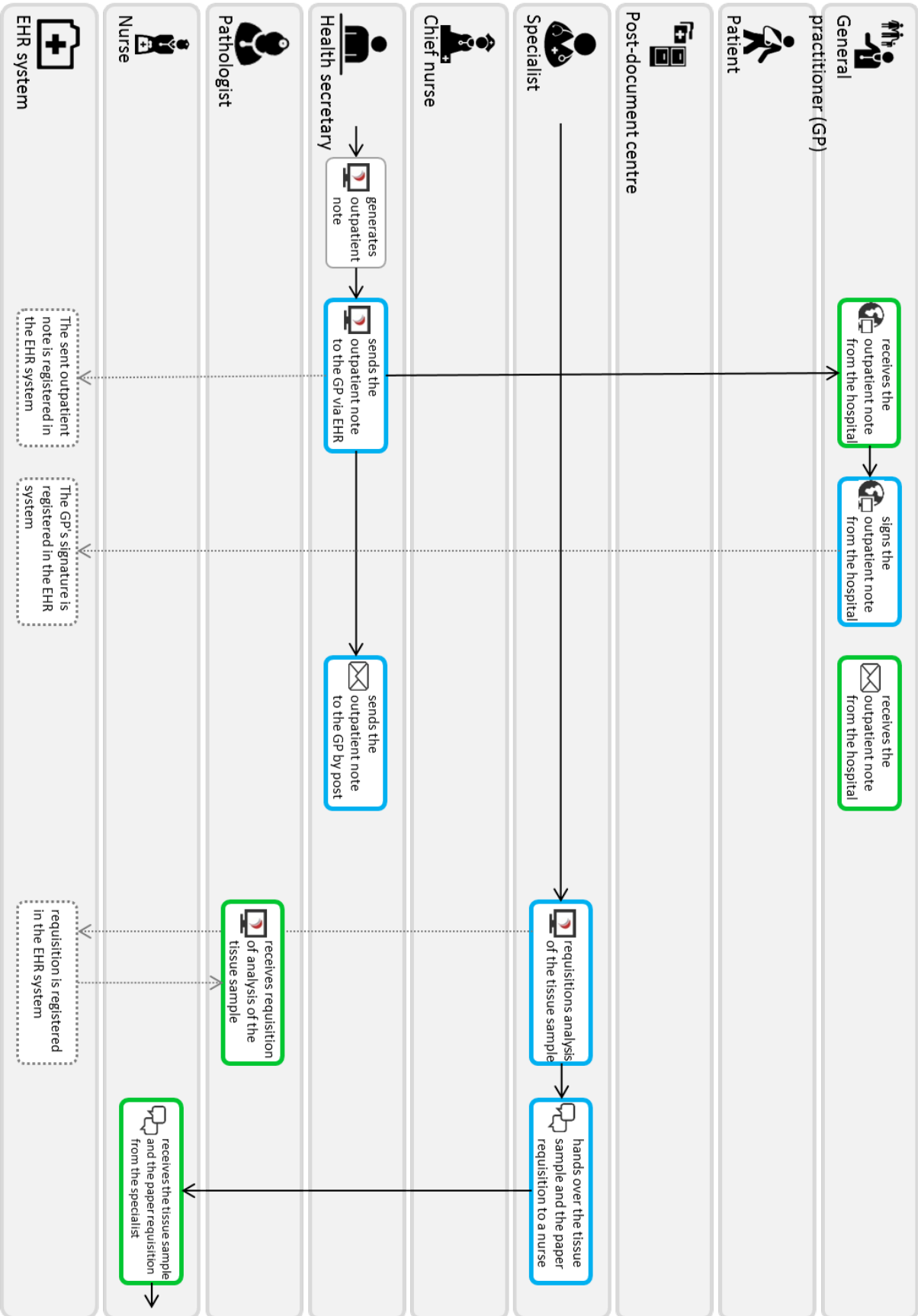
Appendix A.

(6.September 2013)

(6.September 2013)

General practitioner (GP)

receives the outpatient note from the hospital

signs the outpatient note from the hospital

receives the outpatient note from the hospital

Patient

Post-document centre

Specialist

requisitions analysis of the tissue sample

hands over the tissue sample and the paper requisition to a nurse

Chief nurse

Health secretary

generates outpatient note

sends the outpatient note to the GP via EHR

sends the outpatient note to the GP by post

Pathologist

receives requisition of analysis of the tissue sample

Nurse

receives the tissue sample and the paper requisition from the specialist

EHR system

The sent outpatient note is registered in the EHR system

The GP's signature is registered in the EHR system

requisition is registered in the EHR system