

An SHH-BPMN Initiative Report

# IAB203 Assignment 2 Report

SHH-BPMN Process Architecture and Modelling



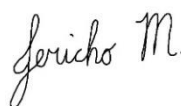
## Group 27

**Submission Date: 7 June, 23:59 (start of week 14)**

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## Executive Summary

The overall purpose of the report is to discuss and specify the Surgic Hospital of 's-Hertogenbosch (SHH) current business operations. The main reason this initiative has been started is to address the critical issues that have emerged from the recent systems upgrade of SHH's billing system. It has also been instantiated to guide future business transformations via a systematic approach to avoid future failed project implementations such as the previous attempt to automate the legacy systems of the SHH. The BPM team is obligated to deliver the outcomes of the pilot project by the end of August 2021 and the detailed work plans for the rest of the hospital by June 2021. This report will include various business process modelling elements, including a process architecture for SHH which includes the support, management, and core processes, with the core processes decomposed, an in-depth business process model, and modelling guidelines as supporting material.

First and foremost, the introduction will establish the context of and the initiative itself, as well as provide a detailed overview of SHH to provide users with an understanding of the organization. The SHH-BPM team is discussed, alongside their goals for both the initiative and in-general regarding their roles at SHH. Moreover, the contents of the report are specified, including their purpose, what stakeholders will find them useful, and how they will find them useful.

This report will also incorporate a comprehensive process architecture which gives a breakdown of the processes of the SHH. It will demonstrate this by having a visual representation of the business's processes via a Process Landscape Diagram. The Process Landscape Model illustrates the corporate processes which gives value to the company. The Process Landscape Model is structured into three process types which are management, core, and support processes. A Value Chain Diagram has also been developed since it shows a visual model of the activities taken by the business. Finally, a process hierarchy has been created which covers the different levels of processes in an abstract way.

To continue, a thorough and comprehensive Business Process Modelling and Notation (BPMN) diagram has also been constructed for the current billing system of the SHH. Ultimately, this aims to provide the SHH an overview of their current billing system. The BPMN diagram portrays all the elements and processes that the current billing system has implemented and how it is executed.

Modelling guidelines have also been established with the aim of it being applied throughout SHH. This is because all process improvements applied to the SHH will originate from the senior and junior project teams of the SHH, and their subsequent process analysis that occurs later in the BPMN lifecycle. Hence, Modelling guidelines has been devised to impose coherency and proper structure to the business process.

The modelling guidelines themselves contain the purpose, target audiences, content summaries, level of detail that will be covered, communication plans and critical governance considerations, since these documents in a company would be separate from the report and thus used independently, meaning it would need those governance concerns inside of them.

## 1. Introduction

The Surgic Hospital of 's-Hertogenbosch (SHH) is a hospital founded in 1895 and is in 's-Hertogenbosch, in the Netherlands. The SHH is an outstanding hospital being among the top 100 hospitals in the world. The hospital specializes on surgical procedures with over 10,000 procedures per year and a total of 40 surgeons and over 200 staff members. As a result of their periodic corporate reviews, it has been established that the SHH needs to act and solve the operational inefficiencies within their administrative business processes. Furthermore, a "Systems Guru" was recruited to develop a system upgrade for current in-house processes and to automate manual processes. However, the development failed due to project delays and implementations. An external audit of the failings of the project strongly recommended that the SHH's business processes should be improved first before executing any further system upgrades and implementations.

The SHH-BPM Team, which was created in July 2020 by the director of SHH, Doctor Smart, has the task of improving process, hospital wide, due to the previously mentioned recommendations and failing of previous project implementations. This 'hospital-wide' initiative is beginning with the focus being on the billing process as a 'pilot' to branch from. Additionally, a junior analyst team has also been recruited to aid the senior SHH-BPM team in executing this and future initiatives. This SHH BPMN team are expected to deliver improvements in user experience control and risk at SHH. It is also anticipated that this business project management report will help in the future identification of areas for cost reduction and system automation of business processes for long term sustainable efficiency.

This report has had process modelling guidelines developed alongside it which has been included in the appendix after the report itself. Two sets of process modelling guidelines are present, one which is targeted at the business process owners, steering committee and for general use at the hospital, and the other for use by the BPMN team. The "Modelling Guidelines for SHH's Business-Area Users" are specifically built to help the stakeholders at SHH to be able to understand the BPMN and process architecture modelling that is contained within the report and that will be used hospital wide for upgrading processes. The "Modelling Guidelines for SHH-BPMN team" are guidelines for the BPMN team on how to distribute, manage, maintain, understand, and create BPMN and process architecture models for the business-area users at SHH.

The report also includes a process architecture of the current processes being performed at SHH, using a combination of existing reference models of hospitals available, and the unique information given surrounding SHH and its specific implementation of the hospital model, accounting for their specialization and focus on surgery. The purpose of the process architecture is to help the understanding of the layout of all the processes occurring at SHH at a high level. The core processes are then delved into deeper to help with further understanding of how the hospital produces value. Furthermore, the billing process at SHH has a process model constructed for it, following the guidelines that are established for the SHH-BPMN team. The model is in BPMN and is useful to business area users and the BPMN team as a current state map of the billing process after its recent upgrade.

The findings of this project will be presented to the hospital board's steering committee. The majority of the steering committee have had no prior experience nor formal training on business process modelling. The steering committee is aware about successful BPM implementations in other institutions, but it is essential that the committee comprehends the content of this report for the recognition and acceptance of recommendations that the report contain. This is so that the future execution of any change in processes that stem from this report can be done correctly, so that the desired automation of processes, improvement in user experience and reduction of costs can occur at SHH, and not be left in stalemate and fail like previous attempts.

## 2. Process Architecture:

### 2.1 Process Landscape:

#### 2.1.1 Process Identification

##### *Management Processes*

- **Facilities Management:**

Facilities Management in the SHH is at most one of the essential and important management processes. Facilities Management incorporates a multitude of disciplines to establish and guarantee the efficient, safety, functionality, and comfort of the hospitals' environment (*Atalian, 2018*). One of the main benefits of having an effective facility management is its ability to save costs. This is essential for the SHH as one of the main problems that is needed to be improved is their high expenses.

- **Develop Vision and Strategy:**

Developing vision and strategy is essential to keep SHH's morals and goals in place. SHH's reputation and credibility could be affected if these are not presented well or put into action. Since SHH have been around for a long time, finding ways to retain their reputation while trying to change for the better would need to be taken into consideration. By creating a detailed plan of what the hospital aims to achieve, in this case cost reductions and automation of business processes, the possibility of it succeeding would be far greater (*van der Stigchel. et al., 2012*).

- **Manage External Relationships:**

External relationships would need to be managed to raise the chances of sponsors as well as other hospitals (*Avis, 2021*). In general, having good relationships with its surrounding hospitals would be useful for SHH in the long run. For instance, in emergencies, SHH would be able to seek help from other hospitals and if they have good relationships, exchanges would be smoother. Relations not only with big organizations but with patients as well. If they have a good experience with SHH, they are more likely to recommend the hospital to their friends and family, benefiting both parties.

- **Risk Management:**

Risk management is also another essential management process as it provides the SHH the opportunity to mitigate and alleviate any potential risk. These risks can range from the possibility of losing important patient records to financial harm to the SHH. Therefore, developing strategies and plans to help avoid any of these catastrophic events shall ultimately improve the SHH's operational and financial efficiency (*University of Illinois at Chicago, 2020*).

- **Financial Management:**

Since one of the main problems that needs to be improved in the SHH is their costs, it is essential to have Financial Management. One of the main roles for Financial Management is to assess and evaluate all the operational costs of the SHH (*Kearnery, 2019*).

- **Systems Management:**

For smooth workflow throughout the hospital System Management is essential. It allows data to be arranged and precise, ensuring anything can be accessed at any time (*Existek, 2019*). This would store all the

patients as well as surgeons' records, financial affairs, supply management, medical histories, test results and many more. It would also be able to show which surgeons are available and their working hours.

- **Care Management:**

After the surgical procedures, patients would need to be taken care of so that they are ready by their discharge date (*McKinney, 2019*). Care management tackles this by keeping track of the patient's needs and ensuring all materials and other equipment available for use.

- **Surgical Procedure Management:**

Surgical Procedure Management ensures the hospital is abiding to the rules and obligations of surgical procedures for its patients. To make sure both patients and medical staff are ready for the surgeries, limiting issues that make come up either before, during or after appointments (*Feige. et al., 2017*).

### Core Processes

- **Surgery:**

Considering Surgic Hospital of 's-Hertogenbosch (SHH) specializes on surgical procedures – with over 10,000 procedure per year and 40 surgeons – surgery is unmistakably a Core Process, directly adding value to external customers: patients. There are a huge range of different surgeries that occur at SHH, but all of them can be reduced down into having a pre-operative phase, intra-operative phase and post-operative phase, with some of the surgical procedures sharing different elements of these three phases, but mostly consisting of vastly different procedures affecting a range of different parts of the human body (*Whitlock, 2012*).

- **Admissions**

- **Consultations:**

Consultations would also be a Core Process because patients would need to consult with the surgeon and/or other medical staff members about the details of their surgery, as well as the benefits and risks of the potential procedure (*van der Stigchel. et al., 2012*).

- **Examinations:**

Examinations would also fall into Core Process because surgeons would need to perform these tests to ensure patients are ready for their surgery.

- **Nursing:**

Nursing occurs at nearly every stage of a patients visit to a hospital, whether directly to the patient or acting behind the scenes in ways to setup for regroup after interactions with the patient. Nursing is when the medical history of a patient is recollected, receives nursing care which can include but are not limited to personal, injury, reporting and specialized care and more. There are three initial care stages when it comes to nursing which is the pre, intra, and post-operative stages of care (*Suganandam, 2019*).

- **Discharge Services:**

The discharge services at the SHH would be provided to patients after the end of their care. Discharge can be transfer, referral or death of the patient (*Healthdirect Australia, 2019*). After the act of discharging the

patient from the hospital, the patient can return to their home or be referred to a different hospital, but discharge services may still continue regarding their billing or post-hospital services.

### *Support Processes*

- **Medical Technology:**

Medical technology doesn't directly add value to a customer but is a support process that assists SHH's surgeons and staff members (*Schatz & Rosen, 1988*). Various amounts and types of technology would be needed to support the many (20) medical departments SHH has — general surgery, gynaecology and neurosurgery to name a few. For example, neurosurgeons would need to use CT scans or MRI scans to make a diagnosis on the patient's brain; the technology being a support to the value being provided to the patient.

- **Human Resources:**

Human Resources (HR) are critical for selecting the high-quality workers to ensure patients receive the best care. As an established organization which solely focuses on surgeries, it is essential that the right staff members are fit for the job. HR would mainly focus on ensuring its more than 200 staff members are satisfied, managing troubleshooting claims and onboarding new hires (*O'Donnell, 2019; Lytle, 2020*).

- **Legal:**

Legal is an essential support process for any organization. Since they are designed to protect the rights of individuals, issues would rise if not followed. Legal support would be required for any interaction between SHH's staff members and its patients if the duty to care is ever breached.

- **Financial Administration:**

Financial Administration is a support process handling all SHH's financial matters. This would include correctly paying their medical staff members, billing for the hospital, buying required goods for SHH to function and ensuring the hospital is making some sort of profit and economic progress (*van der Stigchel. et al., 2012*).

- **Procurement and Inventory:**

Essentially, for SHH to function, inventory and procurement plays a critical role in ensuring its goods and services are secured and available for use in the hospital (*Rossetti. et al. 2008*).

- **Information Technology:**

By automating functions of SHH such as medical records, medication etc. it would make the lives of nurses and other medical staff much easier (*Worldwide Services, 2019*). Medication availability in a database would support staff when prescribing patient, minimizing the issue of prescribing items that are out of stock as well as assisting in letting the patient know about what the hospital has and does not have. In addition, having the patient's records and history in a system, minimizes the risk of being lost or damaged (*Bouronikos, 2020; Mike, 2020*). Instead, it would be ready for the patient's appointment, making the processes smoother.

- **Accounting:**

Accounting is another support process because it is essential in keeping the hospital running. They also handle and monitor the financial aspects of the hospital. These include keeping track of maintenance costs,

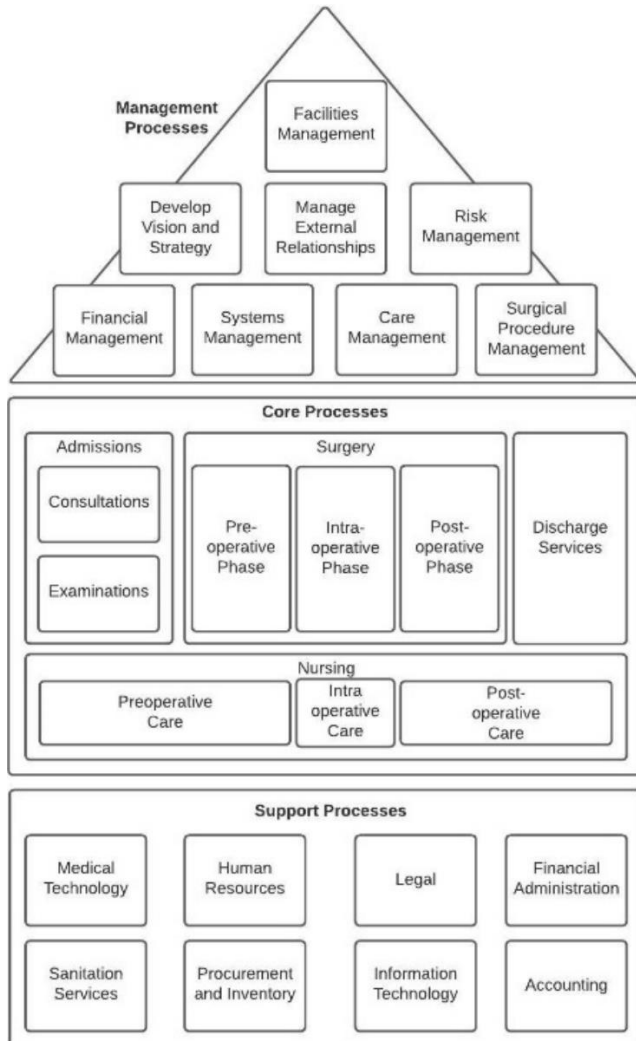


insurance matters and transactions between the hospital and patient, making sure SHH’s money is at the right levels (Rider University, 2019).

2.1.2 Process Landscape Diagram

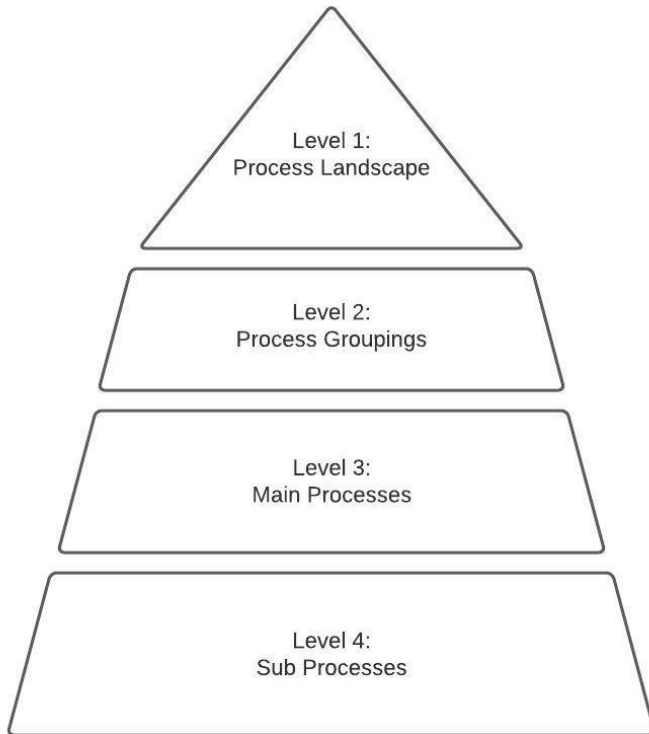
A Process Landscape Diagram has been produced to demonstrate the business’s processes. It illustrates the corporate processes which gives value to the company. The Process Landscape Diagram is structured into three process types which are management, core, and support processes.

**Process Landscape Diagram:**



2.1.3 Process Hierarchy

A Process Hierarchy represents and organizes the processes within the business. It is also the decomposition of the different business processes represented in different levels. The levels illustrated in the hierarchy is highly dependent on the inherent complexity of the business, their focus on the identification of the BPM initiative and the conventions established. For the current project, the Process Hierarchy has been split into four levels.

**Process Hierarchy Diagram:***Level 1: Process Landscape*

The Process Landscape is part of the process architecture for level one. It presents the main processes of the SHH on a very abstract level, to the point where the entire company is represented by a single page. Employees of the company should be able to look at documents in Level 1 and find that they can pinpoint where the processes that they performed would be included. Each element present in the process landscape is further built upon on level two of the process architecture.

*Level 2: Process Groupings*

Process Groupings is in level two which is where the value chain is located. Value chains provide a way to scope processes horizontally and provide a way of demonstrating the order in which different processes are performed. Each chevron containing a process in a value chain is placed in its grouping to highlight how the different processes in the company support each other to provide value to the end customers, which in the case of SHH is the patients in the hospital.

*Level 3: Main Processes*

Main processes are in level three as it illustrates the business processes at a finer degree of granularity. However, these processes are still represented in an abstract way, but start to include BPMN diagrams. The process flows of these processes are demonstrated. Furthermore, each element on this level is illustrated and depicted in an even more detailed level of granularity in level 4.

*Level 4: Sub Processes*

In this level, it represents the sub-process within the main processes in the previous level. In BPMN Diagrams, any major process can have a separate smaller process which has been sub divided and embedded within the said process. These subprocesses may be displayed in their own models or be included in the process models of main processes. Sub-processes can have sub-processes of their own. Sub-processes are filled with tasks or activities which form the basis of the work being done at the hospital, since the entire accumulation of the hospitals function relies on the thousands of individual tasks that occur every day.

## 2.1.4 Decomposed Main Processes

The decomposition of these core processes is derived from the references stated previously regarding the core processes identification descriptions. They are also based on APQC Process Classification Framework for Healthcare Provider (APQC, 2021). *Domain Reference Model for Hospitals* was also a source that the decomposition was derived from (van der Stigchel. et al., 2012).

1.0 ADMISSIONS	
HIERARCHY ID	NAME
1.1	Consultation
1.1.1	Registration of the basic medical data of the patient.
1.1.2	Recollecting all the medical history of the patient.
1.1.3	If information about previous medical history is available, may request additional information and opinions from previous care provider on the treatment and diagnosis.
1.1.4	Evaluation and note taking of the background of the referral in order to determine whether or not the treatment is sufficient and can be delivered.
1.3	Perform a doctor's examination.
1.3.1	Perform a general physical examination of the patient. Including but not limited to reflexes, heart rate, blood pressure etc.
1.4	Evaluate the results of the examinations performed in order to determine a diagnosis.
1.4.1	Assessment of the internal examination results for treatment and diagnosis.
1.4.2	Assessment of the requested additional information and opinion about the treatment and diagnosis.
1.5	Develop and produce a diagnosis based on the information gathered.
2.0 SURGERY	
HIERARCHY ID	Name
2.1	Preoperative Phase
2.1.1	Collect all information regarding the patient's condition, examination results.
2.1.2	Determine all the needs and the risks of the surgery about to be conducted.
2.1.3	Determine the method of how to approach and conduct the surgery whilst also determining the method for anesthesia application.
2.2	Prepare for the surgery
2.2.1	Setup all necessary materials prior to beginning the surgery
2.2.2	Ensure all emergency and backup items are prepared and ready for use.
2.3	Intraoperative Phase
2.3.1	Prep the patient for the surgery and give the patient anesthesia.
2.3.2	Conduct the surgical procedure.
2.3.3	Closely and attentively monitor patient's vital signs. Additionally, all staff included in the undergoing surgery must do their roles to ensure safety and to prevent possible accidents and infections.
2.4	Postoperative Phase
2.4.1	Transfer patient into the necessary room for rehabilitation.
2.4.2	Create a draft surgical report.
3.0 NURSING	
HIERARCHY ID	Name
3.1	Preoperative Care
3.1.1	Develop a good rapport between the patient to build trust.
3.1.2	Inform the patient of the procedures that will be undertaken during the Intraoperative Phase of the surgery.
3.1.3	Compile all the patient's account of medical history.
3.1.4	Ensure all relevant information about the patient is passed to ensure successful delivery during the Intraoperative Phase of the surgery.

<b>3.2</b>	Intraoperative Care
<b>3.2.1</b>	Accompany the patient and help to transport the patient.
<b>3.2.2</b>	Provide more information if needed about the patient.
<b>3.2.3</b>	Perform specialized care.
<b>3.3</b>	Postoperative Care
<b>3.3.1</b>	Identify any problems and collect any info that the patient provides.
<b>3.3.2</b>	Determine, Evaluate, and Perform the care required by the patient.
<b>3.3.3</b>	Provide any surgical-specific instructions and follow ups for further care.
<b>4.0 DISCHARGE SERVICES</b>	
<b>HIERARCHY ID</b>	<b>NAME</b>
<b>4.1</b>	Determine and evaluate all the activities and information required for the patient’s discharge.
<b>4.2</b>	Arrange Follow Up Appointments
<b>4.3</b>	Discharge the patient (which may be transfer to different hospital, referral, or death).
<b>4.4</b>	Patient Billing
<b>4.5</b>	Send extra support needs and information regarding extra care, medicine etc.

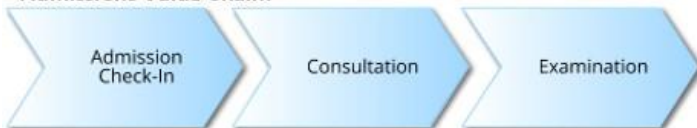
2.2 Value Chains

The main role of value chains is to deliver value to both customers and stakeholders. Value chains can be applied to core, support, and management processes. Furthermore, it also provides a way to horizontally scope processes and identify specialization relations. Multiple Value chain diagrams have been produced to scope out the processes that is valuable to the SHH. The first diagram is a value chain of the SHH itself which incorporates all important processes. Additional value chains have also been produced to represent other processes that exist inside the main surgery value chain (Admission, Surgery, Discharge Services) as well as exist outside of it (Nursing).

**Delivery Surgery Value Chain:**



**Admissions Value Chain:**



**Surgery Value Chain:**



**Nursing Value Chain:**



**Discharge Services Value Chain:**



**Note: Patient Billing Modelled**

## 3. BPMN Model

### 3.1 BPMN Modelling Assumptions

It is assumed that the process starts when the treatments have been applied and the supplies recorded, since this is stated as what needs to occur before a bill can be generated, and the bill being generated is inside of the process.

It is assumed that the “fast online failsafe system” is a tool that is used by the financial staff to submit the invoice, not a piece of software that submits the invoice itself and thus it is not a participant in the process and does not have its own lane in finance. It is added as an annotation with a computer screen image to make sure it is acknowledged that it is included.

It is assumed that the finance of SHH are the participants in the process of submitting and handling the insurance and customer billing. This is not stated in the process description at all, but there is no mention of any process participants other than the doctors and nurses that perform actions before the process starts, and the legal staff of SHH that will file and legal processes afterwards.

It is assumed that if a payment is not received after both the guarantor agency being contacted and missing the two reminders that the patient will then be contacted, and the patient payment handling process started. This is due to their being a huge ambiguity in the ‘as-is billing process’ description. The process description states that “For all of the payments except the contracted insurers, two reminders will be sent, the second one with an added fee”. This is also the case if the non-contracted insurance agency does not pay and misses their second reminder due date. It could be the case that if these external organizations miss the payments, then credit collection and legal action is taken against them, but this was not the interpretation that our BPM-team came to. As this a draft document, clarification and more information is needed regarding the sequence flow of this set of activities.

It is assumed that for each reminder, a new date to be pay is created that if broken, will result in another reminder, till the second of the reminder due dates has been missed where then further actions occurs.

It is assumed that the contracted insurance agency is guaranteed to pay the bill amount that is charged to it. This charge will cover what the patient is covered for by the insurance company.

It is assumed that bill and invoice are interchangeable in the scenario. A bill could be a segment of an invoice, but it was assumed that this was not the case. When referring to segments of a bill, such as the bill segments used in the installments, they are explicitly labelled as “[Segment]”. When referring to the partial or full payment by the insurance, the bill that is given to them may be a part of a bill, or the entire bill, which is what the XOR split is checking when “Further payment required” or “No further payment required”.

It is assumed that hardship requests are analyzed to seem if they are legitimate, and then a decision is made by finance to accept the hardship request and waive the fee or deny it and then have the patient still pay, but in smaller segments with an extended time period.

It is assumed that further hardship requests can be made during installment payments and possibly have the payments refunded if they are waived. It will only cover the payments that have already occurred, which is why it is a multi-instance that is the output of the looping activity.

### 3.2 Modelling Inclusions

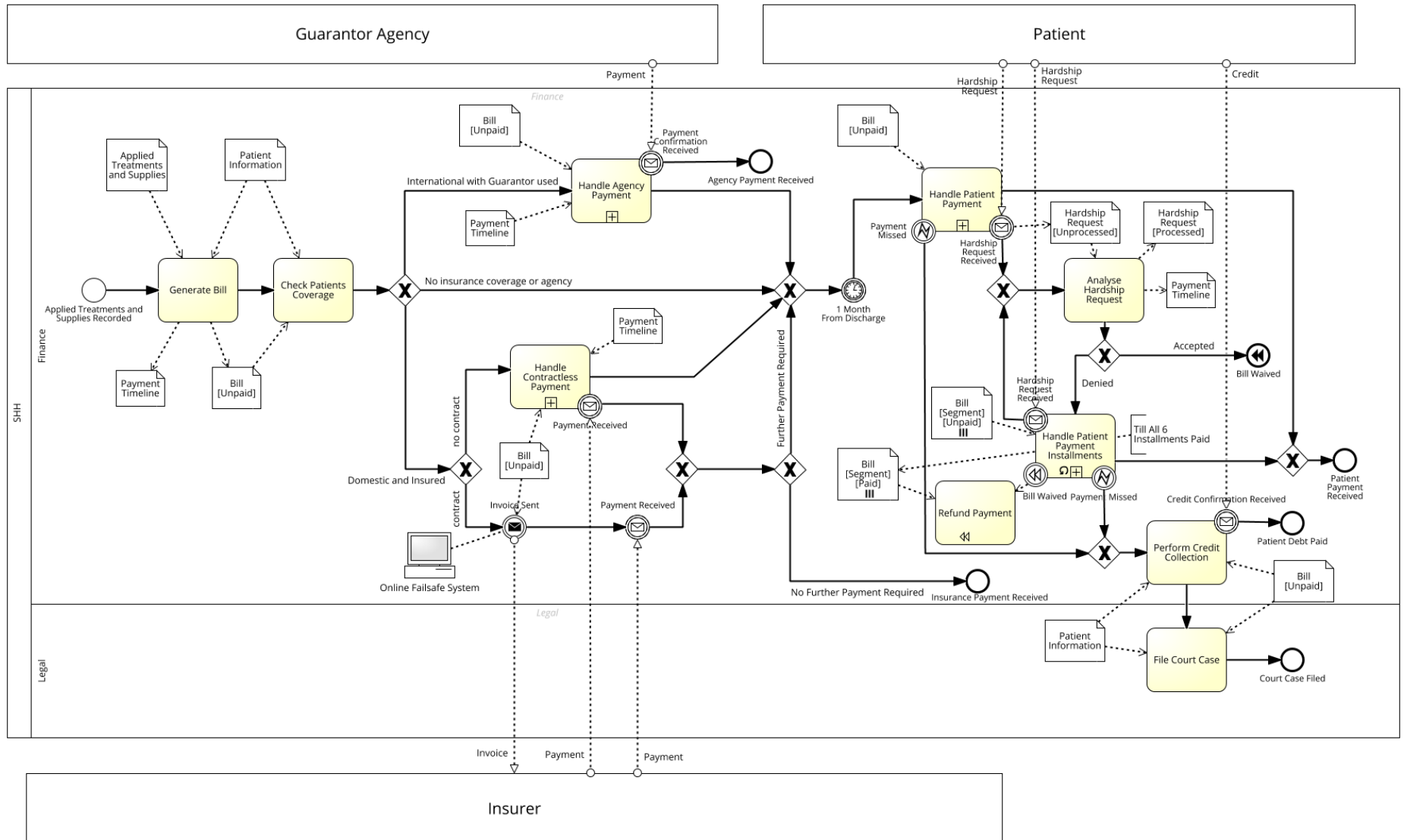
While not stated in the scenario, the type of coverage that a patient has will need to be checked before the XOR split with options is chosen. These options are then divided into “International with Guarantor Used”, “No Insurance or Agency” and “Domestic and Insured”. This is due to some international possibly not having a guarantor agency and some domestic patients not having insurance that covers the current costs. The ability for the patient to request multiple times for a hardship waiver was added as there was a gap in the description. If a bill is waived when the patient has already paid parts of the bill due to it being split up into multiple installments, it was added that the bills that have been paid are refunded. It was assumed that alongside generating an invoice, an internal payment schedule is generated so that the hospital can manage when the payments are supposed to happen. All of the other information from the process description provided in interviews and the assumptions listed above is included.

### 3.3 Modelling Exclusions

There are a few pieces of information are excluded from the model. This information is outside the scope of the process model. The process of nurses and doctors recording the medical treatments and supplies of the patient for the bill to be built from, is not included. This would occur upstream in the value chain and is also out of the scope of financial issues. The activity of credit collection is inside the scope of financial issues and the pursuit of profit for the hospital. However, not enough information is given about what occurs in this process, yet it will be an expansive process that deserves its own process. The internals of the process are excluded when they could have been assumed. The activity of file court case is again, in the scope of the billing process since it is regarding the billing the process and a when negative result of it. The pursuit of a lawsuit and its execution is a process that would occur by the legal staff of SHH. This process could have been assumed, but instead it would be too far outside the jurisdiction of the billing process to place more law based activities in it. The case where the patient does not pay the full amount on the bill is not covered, meaning when a patient receives a bill or bill segment, when they pay they don't pay the entire amount and leave some of the bill leftover. In this case, it would count as a missing payment, since the payment would not be the full amount and the bill would not be paid in full. For the purposes of the diagram, a 'payment' is always in full, and if not, it does not count. This possibility is not mentioned at all, but could be a possibility of occurring in the future.

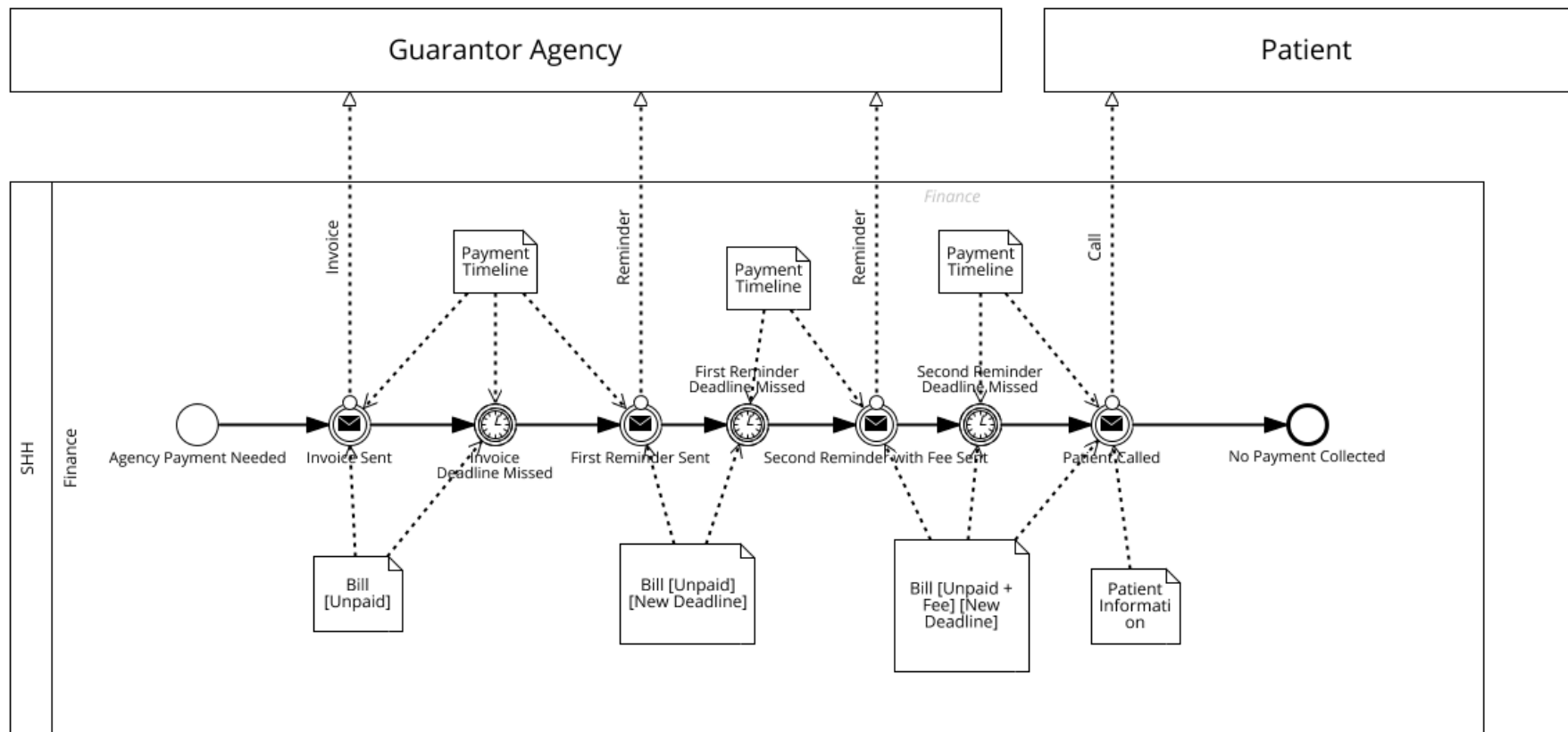
### 3.4 Patient Billing Process Model

3.4.1 Patient Billing Process Model: 07/06/2021: Draft: Version 1.0: Created by Declan Barrett, Jericho Maniquiz, Angela Valencia



**Description:** This is the as-is patient bill process. It is in the “Discharge Services” value chain, which is inside the overall “” It describes the process of gathering a payment for treatments and supplies that have already been used at the hospital for a patient. This payment may come from many sources, but all options lead to the hospital being paid or a lawsuit being filed. Due to the limitations of the information provided, many assumptions were made, with some information being excluded, and other extra information added to fill in the gaps in the interviews. The model has three modelled subprocesses: Handle Agency Payment, Handle Insurance Payment, Handle Patient Payment. The tasks “Handle Patient Payment” and “Handle Patient Payment Installments” link to the same “Handle Patient Payment” subprocess but are labelled differently to distinguish the different uses of “Handle Patient Payment” process, since the bill structure they are given are different.

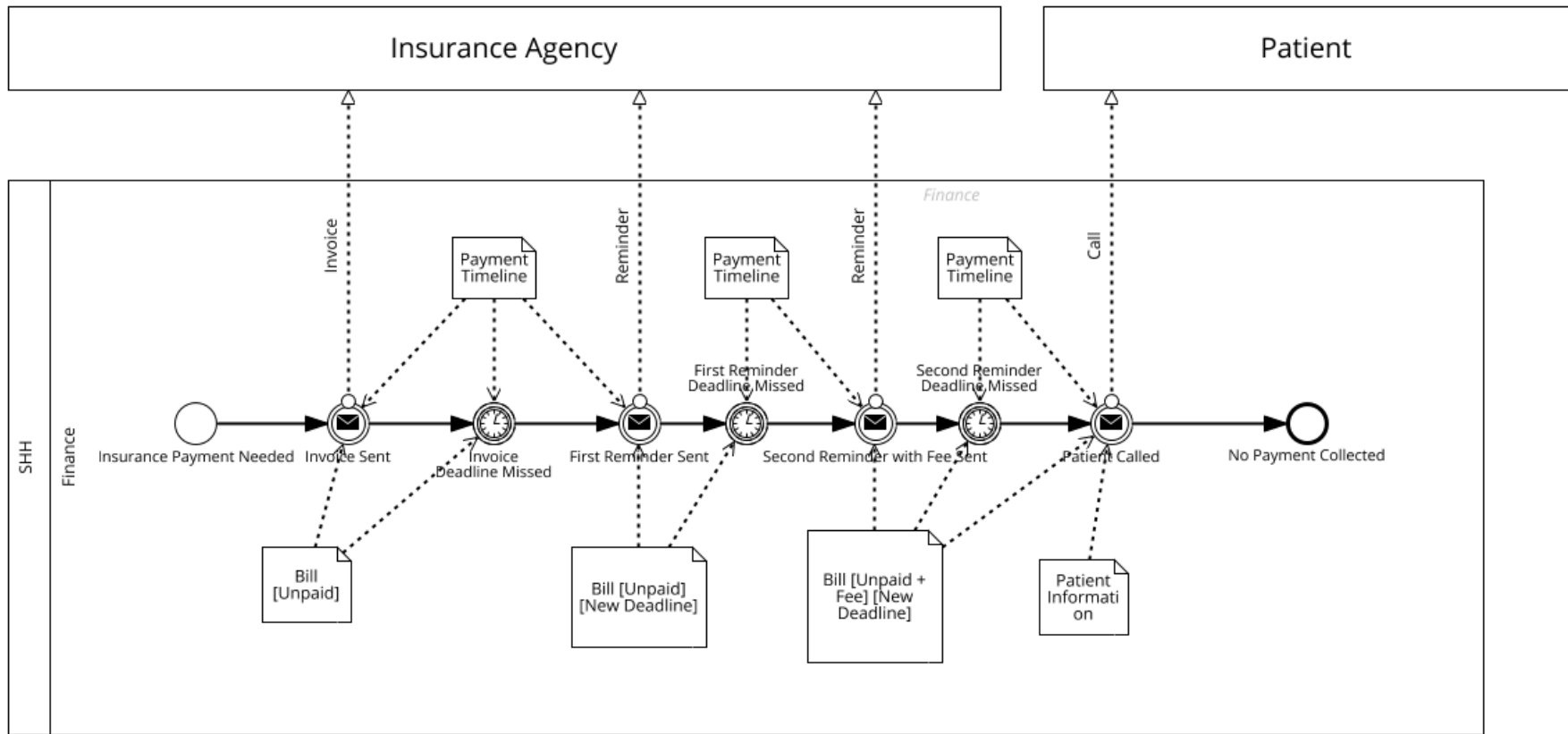
3.4.2 Handle Agency Payment: 07/06/2021: Draft: Version 1.0: Created by Declan Barrett, Jericho Maniquiz, Angela Valencia



**Description:** The “Handle Agency Payment” is for the guarantor agency billing that occurs when a patient is an international patient.

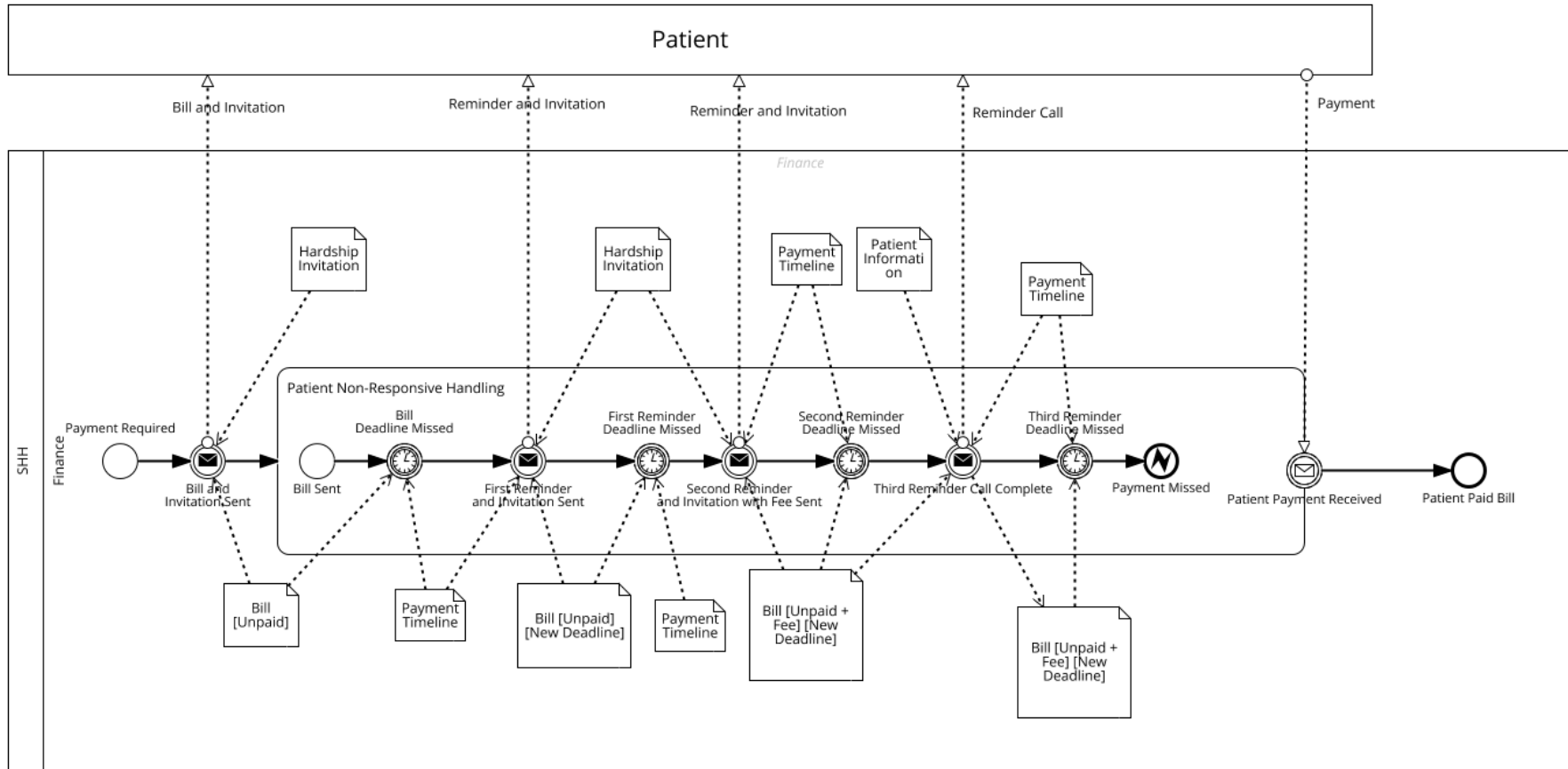


3.4.3 Handle Contractless Payment: 07/06/2021: Draft: Version 1.0: Created by Declan Barrett, Jericho Maniquiz, Angela Valencia



**Description:** The “Handle Contractless Payment” is for billing to insurance agencies that do not have a contract with the hospital, that occurs when a patient is a domestic patient and has insurance.

3.4.4 Handle Patient Payment: 07/06/2021: Draft: Version 1.0: Created by Declan Barrett, Jericho Maniquiz, Angela Valencia



**Description:** The “Handle Patient Payment” is to handle the process of billing a patient. It is used for both a standard bill and a bill segment (for when a hardship request for a waiver is not passed).

## 4. Conclusion

Overall, the report has discussed and assessed the current business operations and processes that has been currently implemented in the Surgic Hospital of 's-Hertogenbosch (SHH). Modelling Guidelines has successfully been developed and implemented to impose coherency and proper structure to the business process. The first Modelling Guidelines have been developed for the SHH's business area users with the aim of having guidelines for them to use for the models created in the initial stages and the models that will be created and maintained by themselves in the long term. The second Modelling Guidelines has been developed for the use of the SHH-BPM team for internal purposes. A Process Architecture has also been successfully created to outline and illustrate the current processes that is currently used in at the SHH. It was developed with the purpose of helping understand the layout of all the current processes within the SHH at a high level. The Process Architecture consists of the process identification, landscape model, hierarchy, decomposed main processes, which show each process within the SHH at a finer degree of granularity, respectively. Furthermore, value chain diagrams have also been developed which illustrates what order the processes undergo and demonstrates a deeper understanding of how the processes give value to the customers and stakeholders. A detailed BPMN Model of the SHH's current business processes has also been created, whilst adhering to the modelling guidelines.

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# Modelling Guidelines for SHH's Business-Area Users

## 1. Introduction

### 1.1 Goals and Purpose

The purpose of the guidelines outlined in *Modelling Guidelines for SHH's Business-Area Users* is to provide the business-area users a way of learning and understanding the Business Process Model Notation (BPMN) models and process architecture diagrams that are included in the report. This set of guidelines is also to help with training and coaching the understanding BPMN and process architecture models, so that these BPMN models can be used throughout the hospital as a way of understanding the processes that occur inside the hospital. It will outline the standards for business process modelling that are used in the accompanying report and can be used as a baseline for understanding the design and implementation of current and future BPMN initiatives that the hospital undertakes.

The current BPMN initiative that is occurring at the Surgic Hospital of 's-Hertogenbosch (SHH) is using the Business Process Modelling Notation as its main language to model processes with. Business Process Modelling Notation provides a notation that is easily understandable by all businesses and has become the industry standard for business process communication, business process design and business process implementation. Business Process Management, the overarching lifecycle that the BPMN notation is used within, is a management discipline that is used to directly increase business process performance, via process identification, process discovery, process analysis, process redesign, process implementation, process monitoring and control. Part of the BPMN lifecycle includes the process identification which builds a process architecture. This process architecture has its own notation like that of BPMN.

Knowledge of the BPMN and process architecture notation, will allow users to be able to understand the BPMN models that the hospital is using to change its processes, enabling a hopefully seamless transitions from the previous processes that were being used, to the new processes that the BPMN initiative has devised.

### 1.2 Audience

The target audience for this set of guidelines includes the following:

- Business Owners
- Hospital Executives and Department Heads
- Process Participants (including but not limited to): Surgeons, Nurses, Support Staff, Administration Staff
- Process Owners

These business-area users will be the ones that are impacted by the results of the BPM initiatives at SHH and will be the ones who are managed and managing the updated business processes. Inside each of the categories, the business area users will be from all the departments of SHH, from the management and department heads, through the nurses, general staff, surgeons and to the support staff performing HR, finance etcetera. The entire staff of SHH, both established, recently recruited and contracted should be able to use this set of guidelines.

### 1.3 Scope

The level of detail that is covered in these guidelines is specifically catered to the target audience and will be covering BPMN to an extent where the reader should be able to grasp how to read and understand a BPM diagram and thus gain value from it via understanding the underlying process. However, it is not in enough detail for those with no modelling experience to be able to become BPMN modelers to the extent of the BPM team. Guidelines for building BPMN models are not included and are instead in the SHH BPM team modelling guidelines. This set of guidelines are to be used organization wide, starting with the current BPMN initiative focused on a "whole-of-hospital" initiative, attempting to make a positive impact on business operations. If this document is not the latest Modelling Guideline for SHH Business Users, as in there is a version of this document which is newer, this document will be out of date and that document should be used in this documents place. The use of this document when there is a newer version available could lead to

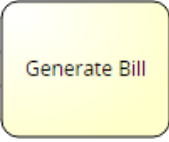
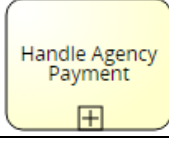

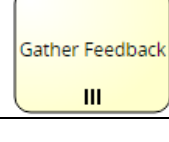
incorrect interpretation of the new models, thus the version and date on this document and other modelling guidelines must be considered.

## 2. Modelling Notations



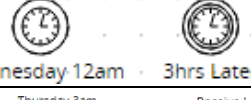
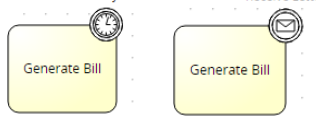
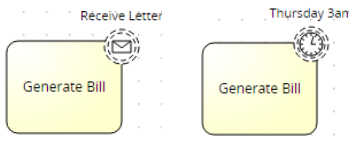
### 2.1 Business Process Modelling Notation

The following is the notation of BPMN 2.0. All the names on the activities and events are example situations where they may end up applying. For instance, “Generate Bill” is an example of how the element “activity” would be seen in a BPMN 2.0 diagram.

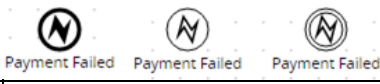

#### 2.1.1 Tasks

Element Name	Element Notation	Element Description
Task/ Activity		A task or activity represents an action that occur. It is a unit of work since it is not a subprocess, but subprocesses may exist inside it that are not yet specified. Activities are denoted by a rectangle with rounded edges and populated by a textual description of the activity in the process.
Subprocess		A subprocess represents that the activity or task has a process within it that is to be executed. A process that a subprocess represents abides by all the same rules as a regular process.
Loop		A looping process represents that the activity or task repeats the activity repeatedly. This is usually accompanied by an annotation that states when the loop is to stop, or it runs till a message or error has occurred.
Multi-Instance		A multi-instance process represents that the activity is performed multiple times simultaneously and does not continue till all instances have concluded executing.

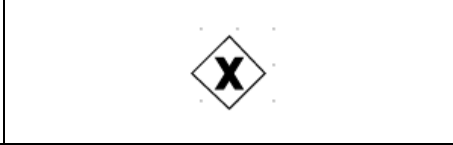
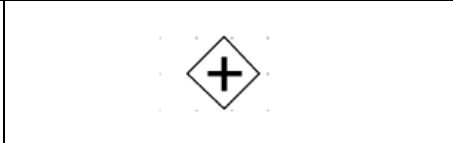
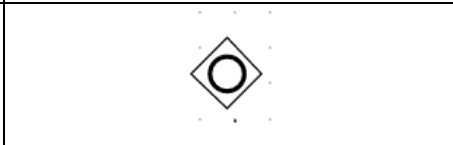

#### 2.1.2 Events

Element Name	Element Notation	Element Description
Event		An event starts the process sequence.
Message Event		A message event starts the process sequence upon the arrival of a message from a different pool, or if having a double border is intermediate and sends and receives messages
Timer Event		A timer event is intermediate and acts as a way of waiting till the specified time accompanying it occurs
Boundary Interrupting Event		A boundary interrupting event is when an activity that is currently being conducted and a boundary event is triggered, the current activity being performed will immediately get cancelled.
Boundary Non-Interrupting Event		A non-boundary interrupting event is when an activity that is currently being conducted and a boundary event is triggered, the current activity being performed will continue in operating simultaneously or in parallel with the flow of the initiated boundary event.

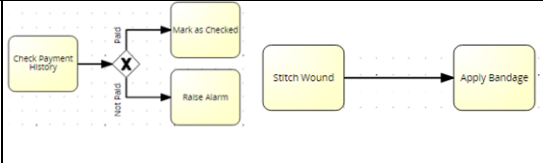
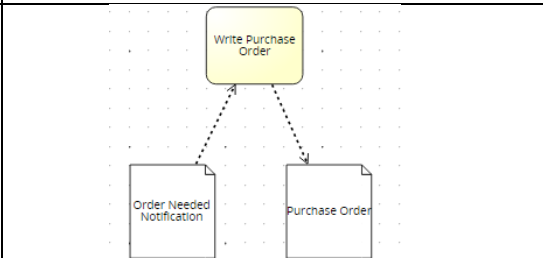
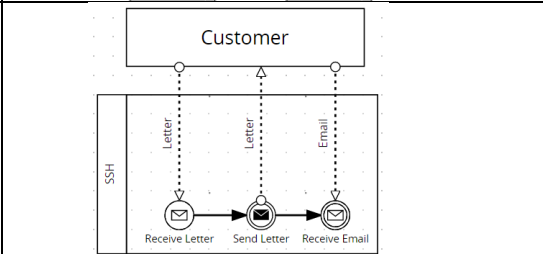


Error Event		Handles the errors occurred after executing a certain activity or at a certain point in the sequence flow.
Terminate Event		The terminate event forces the current process instance and its sub-processes to remove all the active tokens, and immediately end the process

2.1.3 Gateways

Element Name	Element Notation	Element Description
Exclusive (OR) Gateway		Once the token reaches an exclusive (OR) gateway, the sequence flow must only route to one outgoing branch to continue. At the join gateway, it waits for the one incoming branch to complete before proceeding.
Parallel (AND) Gateway		The parallel (AND) gateway allows at least one outgoing branch to be chosen. At the join, the gateway will wait until all active incoming sequence flows are complete before continuing.
Inclusive (AND/OR) Gateway		One or multiple outgoing branches can be chosen when the token reached the inclusive (AND/OR) gateway. When merging back together at the join, it awaits the incoming flows to be completed before continuing the sequence flow.
Event-Based Gateways		Quite like exclusive gateways, event-based gateways only allow one route to be chosen. However, they are only activated when an event triggers it.

2.1.4 Sequence Flows

Element Name	Element Notation	Element Description
Sequence Flow		A sequence flow is used to show the connection between objects. These lines can connect events, activities and gateways within pools or lanes.
Data Association		Data association shows the connection between data inputs and outputs from activities to or from data objects and data stores.
Message Flow		Message flows are used to visualize messages passed between different organizations; attached to pools, activities, or message events.



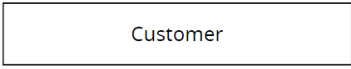
2.1.5 Resources

Element Name	Element Notation	Element Description
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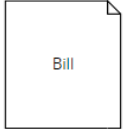
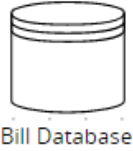
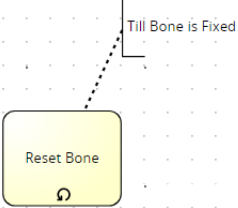
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Pool		A pool represents a participant in a business. This can be an organization, role, or system.
Lane		Pools can be divided into Lanes, categorizing a business participant underneath or inside another organization, role, or system.
Blackbox Pool		A pool which is external to the main business participant that does not have its internal process modelled.


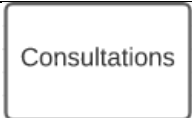
2.1.6 Data Artifacts

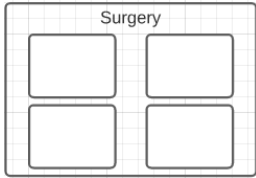

Element Name	Element Notation	Element Description
Data Object		Captures an input or output of a process, which can be anything physical or electronic.
Data Store		Contains data objects that are persisting beyond the scope of the process instance. These data objects inside the database may be used by other process instances or other processes entirely. It is not connected to data objects but used in place of the data object that would be placed inside of it.
Annotation		A piece of connected to text to an element to provide information to the reader of a model. This doesn't affect the follow of tokens through the process but may give information to when a loop stops.

2.2 Process Architecture

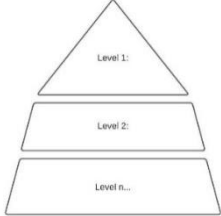
The following is the SHH BPM notation for the process architecture. All the names on the elements are example situations where they may end up applying. For instance, “consultations” is an example of how the element “process group” would be seen in a process architecture diagram.

2.2.1 Landscape

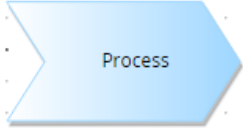

Element Name	Element Notation	Element Description
Process		A process that exists inside the organization. Only allowed inside of an expanded process group. Has the same notation as a non-expanded process group and thus cannot be outside a process group since it would be confused.
Process Group		A box that represents a group of processes. This group may be part of or contain one or many value chains

<p>Process Group Expanded</p>		<p>A box that represents a group of processes, with the processes and/or value chains explicitly described inside of it.</p>
<p>Process Type</p>		<p>A box that contains a range of process groups. The process type box must either be labelled as “Core Processes”, “Support Processes” and “Management Processes”. Usually placed in a house structure with the management placed on top and the support placed on the bottom.</p>

2.2.2 Hierarchy

Element Name	Element Notation	Element Description
<p>Level</p>		<p>A level in a hierarchy specifies what occurs at that depth of the process hierarchy.</p>

2.2.3 Value Chains

Element Name	Element Notation	Element Description
<p>Process</p>		<p>A process in a value chain is a regular process, except that in the value chain it is directly upstream or downstream of other processes</p>
<p>Chain</p>		<p>The chain of business processes signifies that all the processes in the chain are directly related to each other in the order that they are placed in.</p>

3. Modelling Quality Assurance

The quality of a model can be summarized by three dimensions, syntactic quality, semantic quality, and pragmatic quality. The syntactic quality of the model is how well the model follows the language that it is attempting to be displayed in. The semantic quality is how well the model is capturing the reality that it is trying to represent. The pragmatic quality is how useful the model is to the end user. All three of these quality dimensions need to be assessed at all three of the following stages of modelling. During the model development, before approval of the model and after the model has been approved and is in subsequent review. As a business-area user, if you find that a model is not adhering the following guidelines surrounding its syntactic, semantic or pragmatic quality, and issue should be raised with the SHH BPM team so that the model can be reviewed to fix any problems or misconceptions that may have taken place, so that any modelling issues, inconsistencies, mistakes or confusion causing elements do not cascade into the implementation of the processes, or do not continue to be implemented in an inaccurate way.

3.1 Syntactic Quality

Syntactical rules increase model understandability and help to avoid ambiguity.

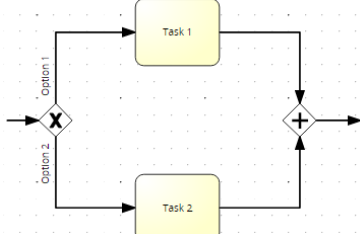
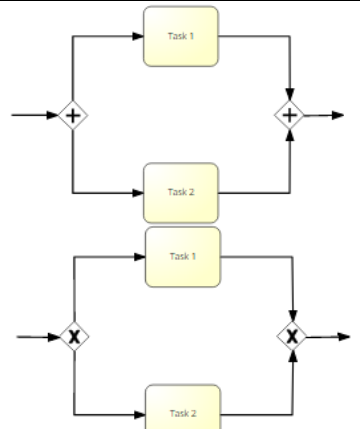
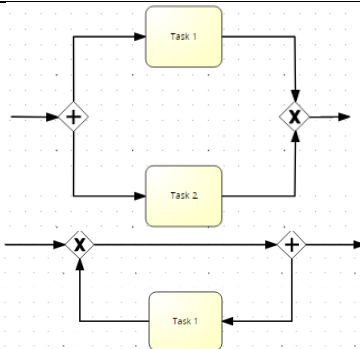
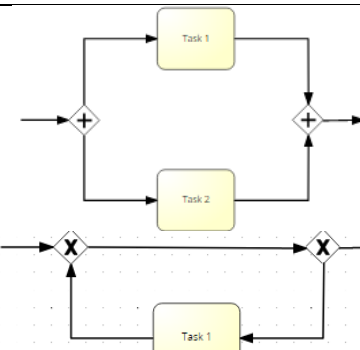
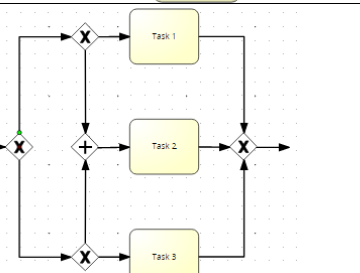
- All BPMN models should be using the BPMN 2.0 notation. This notation is described above in the “Business Process Modelling and Notation” section.
- All BPMN models should be using the BPMN 2.0 syntactical rules surrounding structure and behavior which are described below.

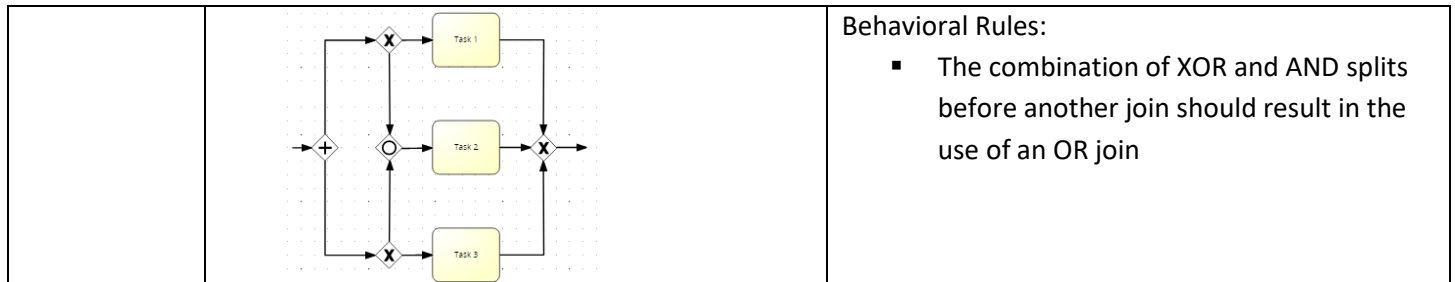
**Structural Rules:** The way the various model elements relate to each other.

- Sequence Flows:
  - All sequence flows must have one element connected to the start of the flow, and one element connected to the end of the flow.
  - Sequence flows are only allowed to connect elements of the same pool. Sequence flows cannot cross boundaries of a pool.
- Data Associations: Can only be connected from and to artifacts like data objects, data stores and annotations, to and from activities and message events, and thus should not connect activities to activities or artifacts to artifacts.
- Message Flows: Must be connected to an element in one pool and either connect to the edge of a blackbox or another element in a different pool.
- Activities: All activities must have at least one incoming and one outgoing sequence flow
- Events:
  - Start events must not have any incoming sequence flows.
  - End events must not have any outgoing sequence flows.
  - Intermediate sequence flows must have an incoming and outgoing sequence flow.
  - Boundary events can link back to the same activity or continue on a separate decision path.
  - Message events should either have an incoming or outgoing message flow.
- Gateways:
  - Split gateways should have exactly one incoming and at least two outgoing sequence flows
  - XOR split gateways:
    - Must have labels on their outgoing sequence flow to denote the option that is being chosen.
    - Must have only one of their decision paths executed, thus the name on the connecting sequence flow should.
  - XOR join gateways:
    - Executes when one of the incoming sequence flows has been completed and thus should have an XOR split prior to it.
  - AND split gateways:
    - Does not have labels on their outgoing sequence flows.
    - All outgoing sequence flows connected to it will be executed.
  - AND join gateways:
    - Executes only when all of the incoming sequence flows have been completed, and thus should have an AND split prior to it.
  - OR split gateways:
    - Must have labels on their outgoing sequence flow to denote the options that are being chosen.
    - One or more of the outgoing sequence flows will be executed.
  - OR join gateways:
    - Proceeds when all active incoming branches have been completed, and thus may be connected to an OR, AND or XOR that was previously implemented in the sequence flow.
  - XOR split gateways:
    - Must have all outgoing sequence flows connected to events, rather than activities.
  - XOR split joins:
    - Must have all incoming sequence flows connected to events.
- BPMN model: All flow nodes must be on a path from a start to and end event.

**Behavioral Rules:** Help to avoid behavioral anomalies.

Behavior	Example	Explanation
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<p><b>Option To Complete</b></p>		<p>A lack of option to complete means that the running process instance cannot complete. In this example, the XOR split only generates one outgoing sequence flow but the AND join requires both sequence flows to have tokens in them, causing a deadlock.</p>
		<p>Behavioral Rules: To enable option to complete:</p> <ul style="list-style-type: none"> <li>▪ Split gateways should have a join gateway further on that matches their type.</li> <li>▪ There should be not hanging activities (the model should be structurally sound)</li> <li>▪ All sequence flows should lead from a start event to an end event, including those that are present in looping structures</li> </ul>
<p><b>Proper Completion</b></p>		<p>A lack of proper completion means that a process instance ends up having multiple tokens reach the same end event. This could occur when an AND split gateway then has an XOR join, meaning that the XOR join is executed twice or more. It may also occur with an XOR join, then an AND split that loop back to the XOR join, meaning the loop infinitely generates tokens, which creates a live lock.</p>
		<p>Behavioral Rules:</p> <ul style="list-style-type: none"> <li>▪ Split gateways should have a join gateway further on that matches their type</li> <li>▪ Looping structures should not contain AND splits and joins unless carefully and properly executed</li> </ul>
<p><b>No Dead Activities</b></p>		<p>Dead activities refer to activities that cannot be executed in any process instance. While the structure may be fine, the combination of split and join gateways can lead to requirements for AND splits that cannot be met.</p>



### 3.2 Semantic Quality

Semantic quality surrounds whether the process model accurately captures the meaning of the process. Whether or not a model is syntactically or pragmatically correct, the model needs to capture the actual objectives and meaning of the real-world processes that are occurring in SHH. When the SHH-BPM team consults you during the creation, redesign, analysis, approval, or implementation of a process model, use the following questions and guidelines to make sure that the model is semantically correct.

**Completeness:** Models need to include all relevant information:

- If there are any missing activities, decisions, data objects etc. that are currently in the business process or need to be in the business process then they need to be mentioned so that the model can include them.
- Every possibility needs to be covered including exceptions that occur in the task. If a business process occurs and there is the opportunity for it to be interrupted, this needs to be mentioned.

**Validity:** Everything that is already in the model needs to be correct and relevant

- Business-area users are the domain experts and thus need to agree on what the models currently have in them.

**Challenges:** Semantic quality can be subjective

- There is no set of formal rules that can be used to easily check whether a model is semantically correct or not, but for the business-area users, they must look at existing models and apply completeness and validity checks.
- Focus is on overall 'meaning', which can be subjective.
- If there are elements that are left out of a process model, it may be the case that the process model that is there is too large. This should still be taken up with the SHH-BPM team, but they may be using the 80/20 rule.

### 3.3 Pragmatic Quality

The pragmatic quality relates to how useful the model is for the business-area users. If a model is not useable by the business-area users then it is not a good model, since BPM and BPMN modelling is a means to the end that is overall improvement in business processes at an organization. In this case, SHH needs the BPM lifecycle and the models within it, to help with the hospital wide initiatives in an attempt to cut costs, increase efficiency in general, improve customer experience and enable the development of process automation. If the models that are being created do not help in these endeavors, then the models themselves, while they may be syntactically or semantically correct, are pragmatically incorrect and thus are a waste of resources to the organization. To help the business users identified the pragmatic quality of models and enable themselves to better use the models so that they can fulfill their purpose and thus be pragmatically correct, the following recommendations should be adhered to.

**Understandability:** Relates to the fact how easy it is to read a specific process model

- Each model needs to be understood by all of the stakeholders that are involved in the creation of the model as well as though who are to implement the model.
- To have the process models have understandability they should adhere to syntax and syntax rules in the syntactic quality section, as well as have the semantic quality rules followed.

- If these syntactic rules and the elements descriptions do not give enough information to understand the model, then the BPM team should be contacted to clarify, so that both the business user can understand the model, and the modelling guidelines can be updated to clarify the missing or miscommunicated information.
- The activity labelling rules must be followed so that it is not confusing for users, and incidents should be reported so it can be updated.
- The visualization and model layout rules must be followed.
- The business taxonomy can be used in reference to SHH terminology that is not understood.
- The BPM taxonomy can be used in reference to BPMN terminology that is not understood.

**Maintainability:** The ability for a process model to be changed at a later date without it being difficult to do.

- The 80/20 rule is the rule where at least 80% of the perspectives, exceptions and actions should be captured in the first version of the model. This is done since it is near impossible to include all 100% of company perspectives in the process model, since organizations such as SHH are incredibly large and the resources that would need to be expended on achieving this are not feasible.
  - As a business-area user do inform the SHH BPM-team that either the perspectives that are currently displayed are not enough and they are missing processes and activities, but do not expect them to be implemented or applied immediately.
- The visualization and model layout rules must be followed.
- The governance aspects, including the stakeholders involved in the model, roles and responsibilities as well as tool support and governance of the modelling repository should all be followed.

**Learning:** The ability for a process model to teach about the process.

- Is to what degree a process model reveals the innerworkings of a process and enables the model to teach the user about what the process does.

**Model Use:** The pragmatic use of a model is subjective.

- There may be many elements that attribute to the usefulness of a model that stem externally from the model.
- As a business-user BPM, the motivation for using the model, your modelling expertise, your previous experience with BPM and previous versions of the BPM model in question may impact your ability to gain value from a model.
- Technological factors may also impact a process models usefulness. As the model technology used is Signavio, if the model is being seen in a non-complete state, then it may be confusing.
- Depending on the implementation of the future hospital systems it may be the case that that system will need to be learnt to be able to have access to the model.

### 3.4 Rule Priorities

Rule priorities depend on the context the model is being used in. For models related to the implementation of computer systems such as automated analysis and automated administration systems, the structural and behavioral correctness are the most important rules to follow. The pragmatic correctness which is received from naming conventions is not at all important to the computer, which needs syntactical correctness. The semantic correctness is less importance than syntax, since without proper syntax it will be completely useless and non-executable, what it actually implements and automates when it is able to run is still important.

For models that are for displaying to the business-area users, the most important is pragmatic correctness, followed by semantic correctness, then syntactical correctness. While each of the rules is intertwined with the other, the pragmatic quality is the most important for humans since it relates to their ability to use the models. As the models presented to them are meant to be able to be used by them, if they are not pragmatically correct then they are practically useless. Semantic correctness is then important since it is about how accurately it reflects reality. Syntactic quality is less important

since a human can use the models even if the notation is not exactly what follows, but it may still effect understanding if the model is syntactically incorrect.

### 3.5 Business Taxonomy

The following is a list of terms and names that is used specifically within SHH. These terms are used by SHH's initiatives, goals, documents, people, and processes.

TERM	DESCRIPTION
API	A set of functions and procedures allowing the creation of applications that access the features or data of an operating system, application, or other service.
Automation	The use or introduction of automatic equipment in a manufacturing or other process or facility.
Bariatric Surgery	Surgery on the stomach and/or intestines to help a person with extreme obesity lose weight ( <i>Davis, 2021</i> ).
Breast and endocrine surgery	Endocrine surgery is a surgical sub-specialty focusing on surgery of the endocrine glands.
Business Analysts	An BPM team member that uses BPM, BPM lifecycle and analysis the processes, to improve the processes, products, services, and software at an organization.
Cardiac Surgery	Cardiac surgery, also called heart surgery, involves surgical operations performed on the heart under to correct life-threatening conditions ( <i>Encyclopedia.com, 2008</i> ).
Colorectal Surgery	Colorectal surgery repairs damage to the colon, rectum, and anus through a variety of procedures that may have little or great long-term consequence to the patient ( <i>Colorectal Surgery - procedure, recovery, test, blood, tube, removal, pain, complications, 2013</i> ).
Endovascular-Hybrid	Endovascular surgery is an innovative, less invasive procedure used to treat problems affecting the blood vessels, such as an aneurysm, which is a swelling or "ballooning" of the blood vessel ( <i>UCSF Health, 2019</i> ).
ENT surgery	ENT Surgery is the specialty concerned with the medical and surgical treatment of the ears, nose, throat ( <i>Fact Sheet – ENT Surgery, 2019</i> ).
Gasrto-Intestinal Surgery	Gastrointestinal surgery is a treatment for diseases of the parts of the body involved in digestion ( <i>Gastrointestinal Surgery, 2016</i> ).
General Surgery	General surgery is a discipline that requires knowledge of and responsibility for the preoperative, operative, and postoperative management of patients with a broad spectrum of diseases, including those which may require nonoperative, elective, or emergency surgical treatment ( <i>Specialty of General Surgery, 2017</i> ).
Gynaecology	The branch of physiology and medicine which deals with the functions and diseases specific to women and girls, especially those affecting the reproductive system.
International Medical Tourist	Involves patients travelling outside of their home country for medical treatment.
Neurosurgery	Surgery performed on the nervous system, especially the brain and spinal cord.
Onco-gynaecology	Gynecologic oncology refers to a branch of cancer care focused on cancers of the female reproductive system.
Oral and Maxillofacial Surgery	Oral and Maxillofacial Surgery is the specialty of dentistry which includes the diagnosis, surgical and adjunctive treatment of diseases, injuries and defects involving both the functional and aesthetic aspects of the hard and soft tissues of the oral and maxillofacial region ( <i>Booth &amp; Diplacido, 2019</i> ).
Orthopaedic	Relating to the branch of medicine dealing with the correction of deformities of bones or muscles.
Pediatric Surgery	Pediatric surgery is defined as the diagnostic, operative, and postoperative surgical care for children with congenital and acquired anomalies and diseases, be they developmental, inflammatory, neoplastic or traumatic ( <i>Specialty of Pediatric Surgery Defined. (2019)</i> ).
Plastic and Reconstructive Surgery	Plastic surgery is a medical specialty concerned with the evaluation and treatment of any physical deformity that can be corrected by surgery, whether acquired or congenital. Reconstructive plastic surgery is usually performed to improve function, but it may be done to approximate a normal appearance.



Robotic and Minimally Invasive Surgery	Robotic surgery, or robot-assisted surgery, allows doctors to perform many types of complex procedures with more precision, flexibility and control than is possible with conventional techniques ( <i>Mayo Clinic Staff, 2021</i> ).
Spinal Surgery	Back surgery is a procedure that aims to change a patient's anatomy, such as removing a herniated disc that is causing pain, with the purpose of providing pain relief ( <i>Back Surgery Definition, 2021</i> ).
SHH	Surgic Hospital of 's-Hertogenbosch (SHH) located in 's-Hertogenbosch, the Netherlands.
Surgeon	A medical practitioner qualified to practise surgery.
Surgical Procedures	A medical procedure involving an incision with instruments; performed to repair damage or arrest disease in a living body.
Urogynecology	Urogynecology a specialized field of gynecology and obstetrics that deals with female pelvic medicine and reconstructive surgery.
Urology	The branch of medicine and physiology concerned with the function and disorders of the urinary system.
Vascular Surgery	Vascular surgery encompasses the diagnosis and comprehensive, longitudinal management of disorders of the arterial, venous, and lymphatic systems, exclusive of the intracranial and coronary arteries.

(*Oxford Learner's Dictionaries, 2021*)

#### 4. Process of Process Modelling

The process of process modelling is split into three phases. The conceptualizing phase, modelling phase and approval phase. Throughout these phases, various stakeholders at SHH will be supporting the SHH-BPM team. As a business-area user, it may be required that at any stage in a BPM initiatives lifecycle that you are called to give support to the BPM team. This support may be in the form of interviews that are conducted with you to attempt to understand the process that you are a part of, own or manage. It may be in the form of workshops, where a group of stakeholders such as yourself meet at a specified time to collaboratively discuss and possibly edit a draft of a process model, attempting to model a process that you are a part of. It may be the case where you, as a subject matter expert (SME) are reviewing the BPM models to make sure that they are semantically sound or are representing a redesign that is genuinely feasible and in scope. Prior to supporting the BPM initiative, it is critical that this set of modelling guidelines is read and understood so that the process of process modelling that is being conducted by the SHH-BPM team will occur smoothly. SHH-BPM training classes will occur before this as a way of easing the SHH staff into being able to work effectively with the BPM changes that may be occurring. During these training classes, this set of guidelines for business-area users will be used.

#### 5. Governance Aspects

##### 5.1 Stakeholders

The stakeholders involved in modelling is the project SHH-BPM team. Additionally, the IAB203 junior analysts' team is also involved to aid the SHH-BPM team with the initiative and have a strong focus on the process modelling components. The Hospital Board steering committee which consists of the director and four vice-directors, the heads of the 20 departments, the division heads of HR, Finance, IT, Asset Management and Patient Services are all key stakeholders as they are responsible for making the regulatory and organizational decisions for the SHH.

Business-area users

##### 5.1.1 Roles and Responsibilities

Roles	Responsibilities
Senior Business Analysts	Perform and facilitate the BPM lifecycle including process identification, process discovery, process analysis, process redesign, process implementation, process monitoring and controlling. Perform upskilling of the staff. Managing and guiding the junior business analysts Doing performance checks and quality checks of the junior business analysts work.

Junior Business Analysts	Perform and facilitate the BPM lifecycle including process identification, process discovery, process analysis, process redesign, process implementation, process monitoring and controlling. Perform lower-level modelling tasks.
Hospital Board Steering Committee	Giving advice and creating decisions about changes as the project progresses and develops. Ensuring that the project delivery will ultimately result in the desired outcome of the project. Monitoring and identifying risks that could potentially hinder or result in a negative outcome to the SHH.
Process Owners	Accurately capture current processes by utilizing business process models. Monitor and identify possible areas of improvement. When possible, process owners will also carry out and execute process improvements in order to support the SHH-BPM team.
General Staff	The staff at the hospital are responsible for being active participants and act as the subject matter experts, giving information and insight to the SHH-BPM team.

## 5.2 Access, Ownership and Maintenance

All stakeholders will be provided access to the models created as soon as the process models have been reviewed and accepted by the hospital board steering committee. This will be done by having access to a central repository of the process models that are staff and public access, so that anyone can get access to the latest models at anytime for any reason. This document, with both sets of guidelines, will also be available to those within SHH in a central repository. Nonetheless, the creators of the models are the ones responsible of keeping the maintenance for their respective models and have their intellectual property covered by the SHH-BPM team

## 5.3 Process Taxonomy

The following is a list of terms and names that is used in BPM. These terms are used in the SHH-BPM team to discuss process modelling and the BPM lifecycle.

TERM	DESCRIPTION
Core Process	A core process is a process that generates value for the business as they are directly linked to the external customers
Management Process	A management process is a process that provides the direction, rules, and practices for all of the other processes in an organization
Support Process	A support process is a process that provides resources to be used by other processes, such as other support processes, core processes and management processes
Business Analyst	An BPM team member that uses BPM, BPM lifecycle and analysis the processes, to improve the processes, products, services, and software at an organization.
Rework	Rework is when a process loops back over the same activities again
Business Process	A chain of events, activities and decisions involving a number of actors and objects, triggered by an event and leading to an outcome that is of value to a customer.
BPM	Business Process Management is a discipline that uses the BPM lifecycle, process identification, process discovery, process analysis, process redesign, process implementation, process monitoring and controlling, to improve business processes.
Modelling Guidelines	Provide details to stakeholders and modelers to be able to understand, use and possibly model process models
Business Transformations	Business transformations are fundamental changes to the processes that an organization conducts. This can include the complete redesign or modification of existing processes and subsequent changes in personnel and technology used.
Process Landscape	A model which is of the highest level that shows the entire organization on a single page. All stakeholders in an organization should be able to look at the diagram and spot which group of processes their job is part of.
Process Hierarchy Levels	The levels of a process hierarchy are the different levels of abstraction in a process architecture. These can range from extremely low level, where the individual pieces of data and precise in-depth map of a part of single process that occurs at the subprocess level, all the way up to the process landscape that abstracts the entire organization onto a single page
Value Chain	Chain of processes an organization performs to deliver value to customers and stakeholders

Stakeholder	A member or the company or an interested party in the company that may have an influence, or be influenced by a business
BPM lifecycle	The BPM lifecycle is the process that occurs inside business process management. The process identification stage produces a process architecture diagram, process discovery produces the current as-is processes for the most important processes, process analysis

#### 5.4 Communication Plan and Versions

All of the staff at SHH will be given access to a central repository containing up to date versions of the BPM models, most likely integrated with the new administration and computer software that will become available throughout the BPM initiatives. The appropriate staff will be given access to their respective set of modelling guidelines. The guidelines for the business-area users will be available to the business-area users. The guidelines will also be actively distributed via email before workshops, interviews and any other formal interaction with the BPM team, as attachments.

#### 6 Reference List

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# Modelling Guidelines for SHH-BPM Team

## 1. Introduction

### 1.1 Goals and Purpose

The purpose of the guidelines outlined in *Modelling Guidelines for SHH-BPM Team* is to provide the SHH-BPM team a way of reassuring themselves of the Business Process Model Notation and process architecture diagrams, as well as being an instruction on how to properly create these diagrams and govern them over their course of use at SHH. This set of guidelines is also to help with training and coaching of new business analysts to be able to create BPMN models so that these BPMN models can be used throughout the hospital as a way of understanding the processes that occur inside the hospital. It will outline the standards for business process modelling that are used in the accompanying report and can be used as a baseline for the creation and understanding of the design, redesign, analysis and implementation of current and future BPMN initiatives that the hospital undertakes.

The current BPMN initiative that is occurring at the Surgic Hospital of 's-Hertogenbosch (SHH) is using the Business Process Modelling Notation as its main language to model processes with. Business Process Modelling Notation provides a notation that is easily understandable by all businesses and has become the industry standard for business process communication, business process design and business process implementation for business process analysts. Business Process Management, the overarching lifecycle that the BPMN notation is used within, is a management discipline that you are a part of and execute daily. Business analysts will be using BPM to directly increase business process performance, via process identification, process discovery, process analysis, process redesign, process implementation, process monitoring and control. Part of the BPMN lifecycle includes the process identification which builds a process architecture. This process architecture has its own notation like that of BPMN.

Knowledge of the BPMN and process architecture notation, and how to properly model with them, will allow the SHH-BPM team to be able to model the BPMN models that the hospital is using to change its processes, enabling the SHH-BPM team to gather an abstraction of the current processes, analyze and redesign these processes and then present them to the business-area users for implementation, in a way that the business-area users will understand since they will have been informed of BPM through the accompanying *Modelling Guidelines for SHH Business-Area Users*.

### 1.2 Audience

The target audience for this set of guidelines includes the following:

- Senior Business Analysts
- Junior Business Analysts
- Contracted Business Analysts
- Recruit and Intern Business Analysts

These BPM-team will be the ones that are impacting others via the active process and results of the BPM initiatives at SHH and will be the ones who are guiding the updated business processes. Inside each of the categories, the BPM team will have a range of different levels of experience, but all should be familiar with the concept of BPM team. As this set of guidelines is specifically for the proper creation and governance of the models, it should not be widely available outside the BPM team.

### 1.3 Scope

The level of detail that is covered in these guidelines is specifically catered to the target audience and will be covering BPMN to a detailed extent where the reader should be able to create BPMN models that are syntactically, semantically, and pragmatically correct. This can range from those with no previous BPM experience all the way through to experts in BPM and need a refresher, since it will still cover the BPM notation but also cover guidelines surrounding how they should

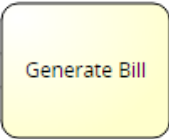


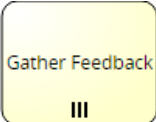
be modelled and then how they should be governed. This set of guidelines should not be used hospital wide but can be used BPM team wide and can be used for the current BPM initiative, and future initiatives. If this document is not the latest Modelling Guideline for SHH-BPM team, as in there is a version of this document which is newer, this document will be out of date and that document should be used in this documents place. The use of this document when there is a newer version available could lead to incorrect modelling of new models, thus the version and date on this document and other modelling guidelines must be considered.

## 2. Modelling Notations



### 2.1 Business Process Modelling Notation

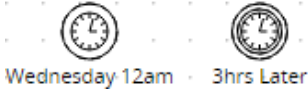
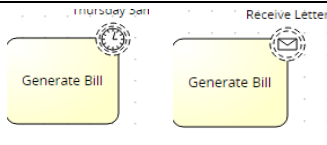
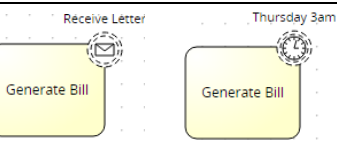


The following is the notation of BPMN 2.0. All the names on the activities and events are example situations where they may end up applying. For instance, “Generate Bill” is an example of how the element “activity” would be seen in a BPMN 2.0 diagram.

#### 2.1.1 Tasks





Element Name	Element Notation	Element Description and Usage
Task/ Activity		A task or activity represents an action that occur. It is a unit of work since it is not a subprocess, but subprocesses may exist inside it that are not yet specified. Activities are denoted by a rectangle with rounded edges and populated by a textual description of the activity in the process. This should not be used if a message event could be used, unless the transferal of a message is accompanied by a task.
Subprocess		A subprocess represents that the activity or task has a process within it that is to be executed. A process that a subprocess represents abides by all the same rules as a regular process.
Loop		A looping process represents that the activity or task repeats the activity repeatedly. This is usually accompanied by an annotation that states when the loop is to stop, or it runs till a message or error has occurred. Can be placed onto a subprocess so that the subprocess is repeated. It is almost like its own subprocess, since it is a shorthand for an XOR split, and an XOR join in a loop formation. Should be accompanied by an annotation to state when the repeating process will stop repeating.
Multi-Instance		A multi-instance process represents that the activity is performed multiple times simultaneously and does not continue till all instances have concluded executing. It is the equivalent of having the same task in parallel using an AND split and join.

#### 2.1.2 Events

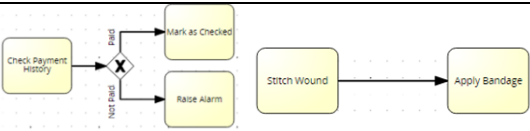
Element Name	Element Notation	Element Description and Usage
Event		An event starts the process sequence. Used when a new process is started, including subprocesses.
Message Event		A message event starts the process sequence upon the arrival of a message from a different pool, or if having a double border is intermediate and sends and

		receives messages. Messages internal to a pool do not need to be demonstrated, other than just sequence flow.
Timer Event		A timer event is intermediate and acts as a way of waiting till the specified time accompanying it occurs.
Boundary Interrupting Event		A boundary interrupting event is when an activity that is currently being conducted and a boundary event is triggered, the current activity being performed will immediately get cancelled.
Boundary Non-Interrupting Event		A non-boundary interrupting event is when an activity that is currently being conducted and a boundary event is triggered, the current activity being performed will continue in operating simultaneously or in parallel with the flow of the initiated boundary event.
Error Event		Handles the errors occurred after executing a certain activity or at a certain point in the sequence flow.
Terminate Event		The terminate event forces the current process instance and its sub-processes to remove all the active tokens, and immediately end the process. Should be used in conjunction with error events.

2.1.3 Gateways

Element Name	Element Notation	Element Description and Usage
Exclusive (OR) Gateway		Once the token reaches an exclusive (OR) gateway, the sequence flow must only route to one outgoing branch to continue. At the join gateway, it waits for the one incoming branch to complete before proceeding.
Parallel (AND) Gateway		The parallel (AND) gateway allows at least one outgoing branch to be chosen. At the join, the gateway will wait until all active incoming sequence flows are complete before continuing.
Inclusive (AND/OR) Gateway		One or multiple outgoing branches can be chosen when the token reached the inclusive (AND/OR) gateway. When merging back together at the join, it awaits the incoming flows to be completed before continuing the sequence flow.
Event-Based Gateways		Quite like exclusive gateways, event-based gateways only allow one route to be chosen. However, they are only activated when an event triggers it.

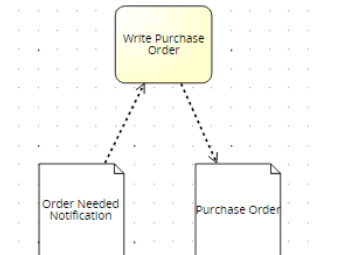
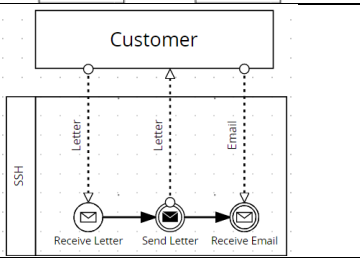
2.1.4 Sequence Flows

Element Name	Element Notation	Element Description and Usage
Sequence Flow		A sequence flow is used to show the connection between objects. These lines can connect events, activities and gateways within pools or lanes.

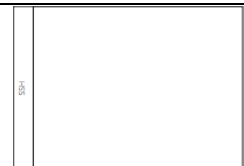
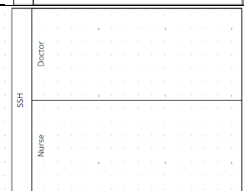
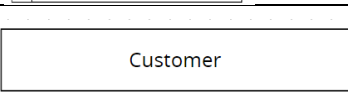
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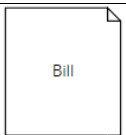
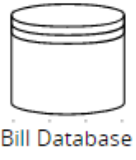
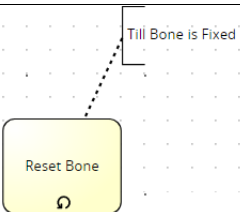
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<p>Data Association</p>		<p>Data association shows the connection between data inputs and outputs from activities to or from data objects and data stores.</p>
<p>Message Flow</p>		<p>Message flows are used to visualize messages passed between different organizations; attached to pools, activities, or message events.</p>

2.1.5 Resources

Element Name	Element Notation	Element Description and Usage
<p>Pool</p>		<p>A pool represents a participant in a business. This can be an organization, role, or system.</p>
<p>Lane</p>		<p>Pools can be divided into Lanes, categorizing a business participant underneath or inside another organization, role, or system.</p>
<p>Blackbox Pool</p>		<p>A pool which is external to the main business participant that does not have its internal process modelled.</p>



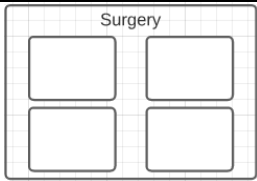

2.1.6 Data Artifacts

Element Name	Element Notation	Element Description and Usage
<p>Data Object</p>		<p>Captures an input or output of a process, which can be anything physical or electronic.</p>
<p>Data Store</p>		<p>Contains data objects that are persisting beyond the scope of the process instance. These data objects inside the database may be used by other process instances or other processes entirely. It is not connected to data objects but used in place of the data object that would be placed inside of it.</p>
<p>Annotation</p>		<p>A piece of connected to text to an element to provide information to the reader of a model. This doesn't affect the follow of tokens through the process but may give information to when a loop stops.</p>

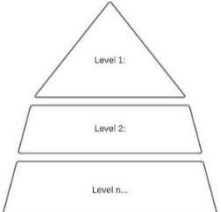
2.2 Process Architecture

The following is the SHH BPM notation for the process architecture. All the names on the elements are example situations where they may end up applying. For instance, “consultations” is an example of how the element “process group” would be seen in a process architecture diagram.

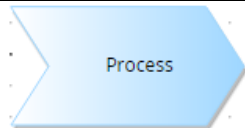

2.2.1 Landscape

Element Name	Element Notation	Element Description
Process		A process that exists inside the organization. Only allowed inside of an expanded process group. Has the same notation as a non-expanded process group and thus cannot be outside a process group since it would be confused.
Process Group		A box that represents a group of processes. This group may be part of or contain one or many value chains
Process Group Expanded		A box that represents a group of processes, with the processes and/or value chains explicitly described inside of it.
Process Type		A box that contains a range of process groups. The process type box must either be labelled as “Core Processes”, “Support Processes” and “Management Processes”. Usually placed in a house structure with the management placed on top and the support placed on the bottom.

2.2.2 Hierarchy

Element Name	Element Notation	Element Description
Level		A level in a hierarchy specifies what occurs at that depth of the process hierarchy.

2.2.3 Value Chains

Element Name	Element Notation	Element Description
Process		A process in a value chain is a regular process, except that in the value chain it is directly upstream or downstream of other processes
Chain		The chain of business processes signifies that all the processes in the chain are directly related to each other in the order that they are placed in.

3. Modelling Quality Assurance

The quality of a model can be summarized by three dimensions, syntactic quality, semantic quality, and pragmatic quality. The syntactic quality of the model is how well the model follows the language that it is attempting to be displayed in. The



semantic quality is how well the model is capturing the reality that it is trying to represent. The pragmatic quality is how useful the model is to the end user. All three of these quality dimensions need to be assessed at all three of the following stages of modelling. During the model development, before approval of the model and after the model has been approved and is in subsequent review. As a BPM-team, the three dimensions should always be at the back of your mind while you are modelling. As a BPM-team member, if you find that a model is not adhering the following guidelines surrounding its syntactic, semantic or pragmatic quality, the creator of the model should be contacted so that the model can be reviewed to fix any problems or misconceptions that may have taken place, so that any modelling issues, inconsistencies, mistakes or confusion causing elements do not cascade into the implementation of the processes, or do not continue to be implemented in an inaccurate way. If you are reviewing your own work and find it doesn't follow the modelling guidelines, then you should immediately correct the issue, within reason, since the longer the process model stays incorrect, the higher likelihood that the problems permeate through the organization as business-area users and BPM-team members access the model.

### 3.1 Syntactic Quality

Syntactical rules increase model understandability and help to avoid ambiguity.

- All BPMN models should be modelled using the BPMN 2.0 notation. This notation is described above in the "Business Process Modelling and Notation" section.
- All BPMN models should be modelled using the BPMN 2.0 syntactical rules surrounding structure and behavior which are described below.

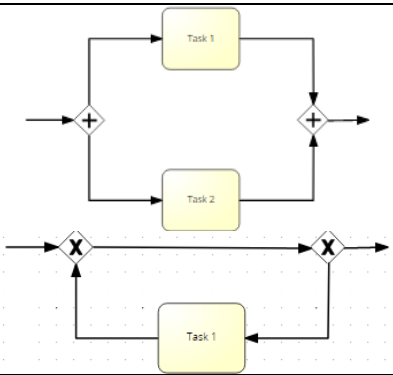
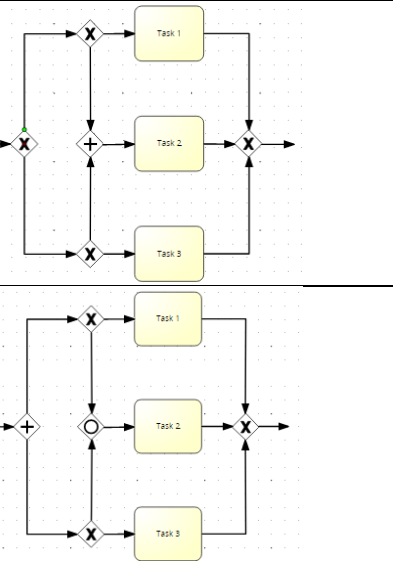
**Structural Rules:** The way the various model elements relate to each other.

- Sequence Flows:
  - All sequence flows must have one element connected to the start of the flow, and one element connected to the end of the flow.
  - Sequence flows are only allowed to connect elements of the same pool. Sequence flows cannot cross boundaries of a pool.
- Data Associations: Can only be connected from and to artifacts like data objects, data stores and annotations, to and from activities and message events, and thus should not connect activities to activities or artifacts to artifacts.
- Message Flows: Must be connected to an element in one pool and either connect to the edge of a blackbox or another element in a different pool.
- Activities: All activities must have at least one incoming and one outgoing sequence flow
- Events:
  - Start events must not have any incoming sequence flows.
  - End events must not have any outgoing sequence flows.
  - Intermediate sequence flows must have an incoming and outgoing sequence flow.
  - Boundary events can link back to the same activity or continue on a separate decision path.
  - Message events should either have an incoming or outgoing message flow.
- Gateways:
  - Split gateways should have exactly one incoming and at least two outgoing sequence flows
  - XOR split gateways:
    - Must have labels on their outgoing sequence flow to denote the option that is being chosen.
    - Must have only one of their decision paths executed, thus the name on the connecting sequence flow should.
  - XOR join gateways:
    - Executes when one of the incoming sequence flows has been completed and thus should have an XOR split prior to it.
  - AND split gateways:

- Does not have labels on their outgoing sequence flows.
- All outgoing sequence flows connected to it will be executed.
- AND join gateways:
  - Executes only when all of the incoming sequence flows have been completed, and thus should have an AND split prior to it.
- OR split gateways:
  - Must have labels on their outgoing sequence flow to denote the options that are being chosen.
  - One or more of the outgoing sequence flows will be executed.
- OR join gateways:
  - Proceeds when all active incoming branches have been completed, and thus may be connected to an OR, AND or XOR that was previously implemented in the sequence flow.
- XOR split gateways:
  - Must have all outgoing sequence flows connected to events, rather than activities.
- XOR split joins:
  - Must have all incoming sequence flows connected to events.
- BPMN model: All flow nodes must be on a path from a start to and end event.

**Behavioral Rules:** Help to avoid behavioral anomalies.

Behavior	Example	Explanation
<p><b>Option To Complete</b></p>		<p>A lack of option to complete means that the running process instance cannot complete. In this example, the XOR split only generates one outgoing sequence flow but the AND join requires both sequence flows to have tokens in them, causing a deadlock.</p> <p><b>Behavioral Rules: To enable option to complete:</b></p> <ul style="list-style-type: none"> <li>▪ Split gateways should have a join gateway further on that matches their type.</li> <li>▪ There should be not hanging activities (the model should be structurally sound)</li> <li>▪ All sequence flows should lead from a start event to an end event, including those that are present in looping structures</li> </ul>
<p><b>Proper Completion</b></p>		<p>A lack of proper completion means that a process instance ends up having multiple tokens reach the same end event. This could occur when an AND split gateway then has an XOR join, meaning that the XOR join is executed twice or more. It may also occur with an XOR join, then an AND split that loop back to the XOR join, meaning the loop infinitely generates tokens, which creates a live lock.</p>

		<p>Behavioral Rules:</p> <ul style="list-style-type: none"> <li>▪ Split gateways should have a join gateway further on that matches their type</li> <li>▪ Looping structures should not contain AND splits and joins unless carefully and properly executed</li> </ul>
<p><b>No Dead Activities</b></p>		<p>Dead activities refer to activities that cannot be executed in any process instance. While the structure may be fine, the combination of split and join gateways can lead to requirements for AND splits that cannot be met.</p> <p>Behavioral Rules:</p> <ul style="list-style-type: none"> <li>▪ The combination of XOR and AND splits before another join should result in the use of an OR join</li> </ul>

3.2 Semantic Quality

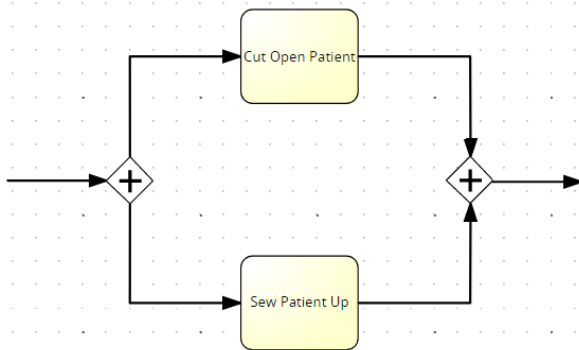
Semantic quality surrounds whether the process model accurately captures the meaning of the process. Whether or not a model is syntactically or pragmatically correct, the model needs to capture the actual objectives and meaning of the real-world processes that are occurring in SHH. As a business analyst, a part of the BPM lifecycle is gathering the current processes and the details of these processes. This requires gathering information from the business-area users and accurately converting that information to the model so that it can be known hospital wide. The actual process of gathering this information accurately is covered in this section and in the process of process modelling part of the guidelines. When modelling the model from information already collected from the subject matter experts use the following questions and guidelines to create semantically correct models.

**Completeness:** Models need to include all relevant information:

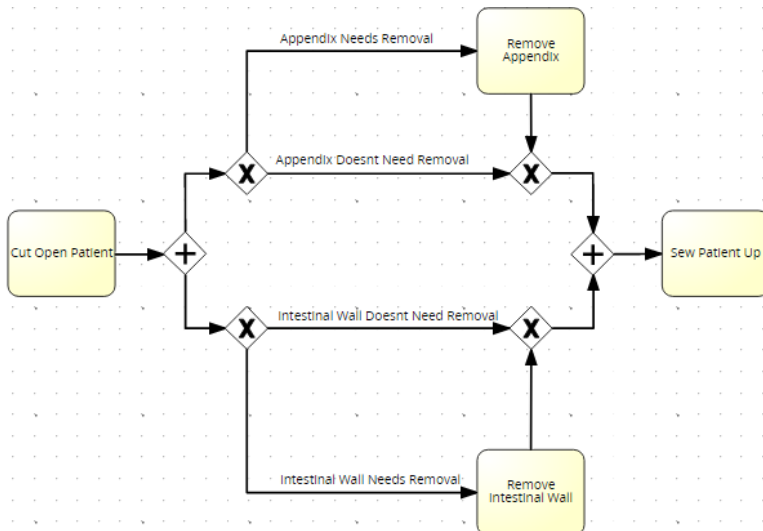
- Make sure to collect all activities, decisions, data objects etc. that are currently in the business process. There are various ways of asking for this information, but it definitely needs to be included. However, using the 80/20 rule that is described later in maintainability, is it okay if all perspectives of the process are not covered initially.
- Every possibility needs to be covered including exceptions that occur in a task and process. If a business process occurs and there is the opportunity for it to be interrupted, this needs to be included in the process model.
- All of the active participants in a model need to be included
- Information and processes of external participants, such as customers, does not need to be included and can be represented by Black boxes

**Validity:** Everything that is already in the model needs to be correct and relevant

- Business-area users are the domain experts and thus need to agree on what the models currently have in them. This will occur from consultation with the subject matter experts during interviews that need to be scheduled and possibly through workshops.
- There are many semantic problems that can occur:
  - Incorrect order of process flows: The order of a process flow may not represent the reality of the process. Common mistakes that result in this problem are the incorrect use of splits and joins, resulting in some tasks being represented in parallel when they are not parallel. This is what is occurring the example below, where the patient could be cut open and then sewn up, or could be sewn up and then cut open, due to the parallel nature of the AND split and AND join. It is also possible that the incorrect order of execution simply comes from a miscommunication between the subject matter experts and the BPM-team. An example would be where to cut open the patient was actually said to occur at the same time as sewing a patient up, but they were referring to a separate patient, since a nurse was being interviewed etc.



- Incorrect paths of execution: There are paths of token flow that are included that cannot occur in the reality of the process. Common mistakes that result in this problem are again the incorrect user of splits and joins, resulting in some flows that do not exist and possibly bypassing tasks. An example would be an appendix removal procedure, where a patient has systems related to appendicitis, and the appendix either needs to be removed, or it doesn't cause it isn't the appendix that is inflamed, it could be that the intestinal wall is inflamed next to the appendix, or it isn't and doesn't need remove, or both. However, it cannot be neither, but due to the use of XOR and AND instead of OR splits and joins, the process flow of neither being removed is an option. This could have occurred through poor modelling practice which needs to be avoided to make sure that the information given is accurately represented, or it could have been.



**Challenges:** Semantic quality can be subjective

- There is no set of formal rules that can be used to easily check whether a model is semantically correct or not, but for the BPM-team, they must create models and look at existing models and apply completeness and validity checks.
- Focus is on overall 'meaning', which can be subjective, but should be conveyed by the business-area user
- If there are elements that are left out of a process model, it may be the case that the process model that is there is too large. This could be from the 80/20 rule of it could be in a different process model.
- Sequence Flows: Should always be between activities that are genuinely related to each other in the process flow. If there is another process that is performed before the process, then the process flow should be connected to that activity instead.
- Data Associations: If an activity requires a data object then the association flows from the data object to the task. This data object needs to be available before the task executes. If the data object is produced by the object then the data association goes from the activity to the data object. The incorrect direction of a data object can lead to the semantics of the model being incorrect.

### 3.3 Pragmatic Quality

The pragmatic quality relates to how useful the model is for the business-area users. If a model is not useable by the business-area users then it is not a good model, since BPM and BPMN modelling is a means to the end that is overall improvement in business processes at an organization. In this case, SHH needs the BPM lifecycle and the models within it, to help with the hospital wide initiatives in an attempt to cut costs, increase efficiency in general, improve customer experience and enable the development of process automation. If the models that are being created do not help in these endeavors, then the models themselves, while they may be syntactically or semantically correct, are pragmatically incorrect and thus are a waste of resources to the organization. When modelling and reviewing models the following recommendations should be adhered to.

**Understandability:** Relates to the fact how easy it is to read a specific process model

- Each model needs to be understood by all of the stakeholders that are involved in the creation of the model as well as those who are to implement the model.
- To have the process models have understandability they should adhere to syntax and syntax rules in the syntactic quality section, as well as have the semantic quality rules followed.
- If a business-area user contacts the BPM-team surrounding understanding a BPM model or the modelling guidelines, or a change that needs to be made to a model or the modelling guidelines, then their considerations and questions should be answered immediately. It is the BPM-teams responsibility to make sure that the business-area users understand the BPM models that are produced by them. That involves modifying models to make them easier to read and modifying the guidelines to make it easier for them learn BPM.
- The activity labelling rules must be followed so that it is not confusing for users.
- The visualization and model layout rules must be followed.
- The business taxonomy can be used in reference to SHH terminology that is not understood.
- The BPM taxonomy can be used in reference to BPMN terminology that is not understood.

**Maintainability:** The ability for a process model to be changed at a later date without it being difficult to do.

- The 80/20 rule is the rule where at least 80% of the perspectives, exceptions and actions should be captured in the first version of the model. This is done since it is near impossible to include all 100% of company perspectives in the process model, since organizations such as SHH are incredibly large and the resources that would need to be expended on achieving this are not feasible.
  - As a BPM-team member listen to the business-area users if they notice that model is missing activities or processes.

- These changes do not have to be implemented immediately since it may be the case that the information that is being provided is not related to the current initiative, or contradicts with existing information.
- The visualization and model layout rules must be followed.
- The governance aspects, including the stakeholders involved in the model, roles and responsibilities as well as tool support and governance of the modelling repository should all be followed.

**Learning:** The ability for a process model to teach about the process.

- Is to what degree a process model reveals the inner workings of a process and enables the model to teach the user about what the process does.
- If the process model is not readable due to its maintenance or understandability, or is semantically incorrect, then its ability to teach is severely limited, and the process model needs to be remade.

**Model Use:** The pragmatic use of a model is subjective.

- There may be many elements that attribute to the usefulness of a model that stem externally from the model.
- A business-user's pragmatic experience with a model may change depending on their:
  - Motivation for using the model
  - Modelling expertise
  - Previous experience with BPM
  - Previous experience with previous versions of the BPM model
  - Modelling technology used
  - Storage technology used
- You will need to consider whether the problem the user is having is due to these aspects, or whether the model is actually unsuitable for use. These should be considered before attempting to change any parts of an existing model, since it could be the case that the user does not actually have a problem that is relevant to the current working model, but has a problem with the situation it is presented in.
- If there is an external issue, it should be resolved by working with the business-area users to discover why the problem is occurring and fixing it, since if the problem is not fixed, other business-area users may repeatedly contact the BPM-team over non-BPM issues.

### 3.4 Labelling Rules

There is a range of labelling rules that need to be maintained in the process models, and thus if they are not being followed, the pragmatic quality of the model will drop significantly.

- The size of the labels and text on all process models should be between 10-12 font size.
- The text should be the color black, with the background behind it being white so that the text is easy to identify and read.
- The length of labels should be concise as possible. An element label should have less than seven words, or else the label will turn into a full description.
- Labels should not overlap with other elements or other labels, other than for message or sequence flow lines. This sometimes cannot be avoided.
- Activity labels must be of the verb + noun structure. The labels for activities are placed within the box that is the activity, thus the label must be able to fit in the process element box.
- Sub process labels for expanded subprocesses are placed at the top left-hand corner of the box. It is better to expand the box to be able to have it in a non-obstructive way. Regular non-expanded subprocesses are treated the same as activity labels.
- Event labels must be of the form noun + past participle verb. These labels are placed below the event. However, if a message sequence is flowing in from the bottom, then it can be moved to on top or directly beside the event.

- Labels for message events should be easily readable and not lying parallel with the message event that they are describing. This is so the viewer does not have to turn their head to see what the message being sent to it is.
- Timer event labels should describe a space in time, this can either be a set date and time, like “Wednesday 3am” or can be context dependent such as “3hrs Later.”. If this information is gathered from a data object it should be connected to it.
- Error events need to be labelled as a regular end event, accept the that they need to match up with the catching error event.
- Sequence flows should not be labelled apart from when they are being produced by an XOR or OR split gateway. In this case, the label needs to describe the option that is to be chosen by taking the path. This usually consists of a noun.
- Data associations should not be labelled, apart from the artifact that they are attached to. Data objects should be labelled with a noun and possibly an adjective describing what they are, and possibly the state they are in if it changes throughout the process.
- Pools should be labelled in a box to the left of the process model and use a noun to describe what or who the process participant is.
- A lane should have both a label on the left-hand side of the lane as well as faded out in the top and should be labelled with a noun that describes the process participant.
- BPMN model headers should be labelled with the meta data of the model. This includes the creator of the model, creation date, current status and version, title of the model and a description of the model.

### 3.5 Visualization or Model Layout Rules

The visualization and model layout rules depict how the models that are created should be laid out. Having a model laid out properly results in its pragmatic quality increase since it is able to be easy to read, increases understanding and is more accessible, since it does not require an in-depth examination of the process model just to gather meaning from it.

- The colors of the process model should be monotone and follow the default, off-white, white and black of Signavio. Signavio has chosen these colors as they are easily readable.
- The layout of the elements should be from the top left to the bottom right. At no point should a start event be further to the right than an end event. Left to right should be prioritized over top to bottom.
- At no point should a sequence flow cross over another sequence flow. Message flows and data associations can cross over message flows but should not cross over other message flows and data associations if it can be avoided.
- Sequence flows should be as straight as possible while also being vertical or horizontal. They can be at an angle of there is no space on an existing split or join.
- While BPMN 2.0 supports shorthand for splits and joins where the splits and joins are not explicitly stated but instead are written in a shorthand form where they directly come out and enter into activities and events.
- The spacing of elements should be at least one segment part in Signavio. This is equivalent to 1 line spacing on an A4 piece of paper. This spacing should also apply to the gap between labels, to not make it confusing.
- A BPMN model should be able to fit on a single page, including the spacing guidelines, thus when zoomed out to fit the page, the entire model should be readable.
- A maximum of 30 elements should be placed on a single page, with subprocesses being used to decrease complexity but still keep detail.
- As few elements should be used in the model as possible to accurately display the information. If there is an alternative element, such as displaying an XOR and AND as an OR, it should be used, as long as it doesn't break the semantics of the model. OR splits and joins can be difficult to use so they should be double checked to make sure that they are correct.

- The amount of pathing routes for each element in a model should be reduced since a very complex model with sequence flows that intertwine can be incredibly difficult to understand. However, this sometimes cannot be avoided.
- There should be one start event for each trigger of a process and one end event per outcome of a process. Different types of outcomes can be abstracted into one, or separated depending on structure and context of the model.
- Elements should be spaced out equally from each other, meaning the sequence flows between them should be the same length if possible.

Overall, the consistency of the process models is incredibly important to reduce confusion and increase pragmatic quality and help reassure the semantic and syntactic quality of the models.

### 3.6 Rule Priorities

Rule priorities depend on the context the model is being used in. For models related to the implementation of computer systems such as automated analysis and automated administration systems, the structural and behavioral correctness are the most important rules to follow. The pragmatic correctness which is received from naming conventions is not at all important to the computer, which needs syntactical correctness. The semantic correctness is less importance than syntax, since without proper syntax it will be completely useless and non-executable, what it actually implements and automates when it is able to run is still important.

For models that are for displaying to the business-area users, the most important is pragmatic correctness, followed by semantic correctness, then syntactical correctness. While each of the rules is intertwined with the other, the pragmatic quality is the most important for humans since it relates to their ability to use the models. As the models presented to them are meant to be able to be used by them, if they are not pragmatically correct then they are practically useless. Semantic correctness is then important since it is about how accurately it reflects reality. Syntactic quality is less important since a human can use the models even if the notation is not exactly what follows, but it may still effect understanding if the model is syntactically incorrect.

### 3.7 Business Taxonomy

The following is a list of terms and names that is used specifically within SHH. These terms are used by SHH's initiatives, goals, documents, people, and processes.

TERM	DESCRIPTION
API	A set of functions and procedures allowing the creation of applications that access the features or data of an operating system, application, or other service.
Automation	The use or introduction of automatic equipment in a manufacturing or other process or facility.
Bariatric Surgery	Surgery on the stomach and/or intestines to help a person with extreme obesity lose weight ( <i>Davis, 2021</i> ).
Breast and endocrine surgery	Endocrine surgery is a surgical sub-specialty focusing on surgery of the endocrine glands.
Business Analysts	An BPM team member that uses BPM, BPM lifecycle and analysis the processes, to improve the processes, products, services, and software at an organization.
Cardiac Surgery	Cardiac surgery, also called heart surgery, involves surgical operations performed on the heart under to correct life-threatening conditions ( <i>Encyclopedia.com, 2008</i> ).
Colorectal Surgery	Colorectal surgery repairs damage to the colon, rectum, and anus through a variety of procedures that may have little or great long-term consequence to the patient ( <i>Colorectal Surgery - procedure, recovery, test, blood, tube, removal, pain, complications, 2013</i> ).
Endovascular-Hybrid	Endovascular surgery is an innovative, less invasive procedure used to treat problems affecting the blood vessels, such as an aneurysm, which is a swelling or "ballooning" of the blood vessel ( <i>UCSF Health, 2019</i> ).
ENT surgery	ENT Surgery is the specialty concerned with the medical and surgical treatment of the ears, nose, throat ( <i>Fact Sheet – ENT Surgery, 2019</i> ).



Gasrto-Intestinal Surgery	Gastrointestinal surgery is a treatment for diseases of the parts of the body involved in digestion ( <i>Gastrointestinal Surgery, 2016</i> ).
General Surgery	General surgery is a discipline that requires knowledge of and responsibility for the preoperative, operative, and postoperative management of patients with a broad spectrum of diseases, including those which may require nonoperative, elective, or emergency surgical treatment ( <i>Specialty of General Surgery, 2017</i> ).
Gynaecology	The branch of physiology and medicine which deals with the functions and diseases specific to women and girls, especially those affecting the reproductive system.
International Medical Tourist	Involves patients travelling outside of their home country for medical treatment.
Neurosurgery	Surgery performed on the nervous system, especially the brain and spinal cord.
Onco-gynaecology	Gynecologic oncology refers to a branch of cancer care focused on cancers of the female reproductive system.
Oral and Maxillofacial Surgery	Oral and Maxillofacial Surgery is the specialty of dentistry which includes the diagnosis, surgical and adjunctive treatment of diseases, injuries and defects involving both the functional and aesthetic aspects of the hard and soft tissues of the oral and maxillofacial region ( <i>Booth &amp; Diplacido, 2019</i> ).
Orthopaedic	Relating to the branch of medicine dealing with the correction of deformities of bones or muscles.
Pediatric Surgery	Pediatric surgery is defined as the diagnostic, operative, and postoperative surgical care for children with congenital and acquired anomalies and diseases, be they developmental, inflammatory, neoplastic or traumatic ( <i>Specialty of Pediatric Surgery Defined. (2019)</i> ).
Plastic and Reconstructive Surgery	Plastic surgery is a medical specialty concerned with the evaluation and treatment of any physical deformity that can be corrected by surgery, whether acquired or congenital. Reconstructive plastic surgery is usually performed to improve function, but it may be done to approximate a normal appearance.
Robotic and Minimally Invasive Surgery	Robotic surgery, or robot-assisted surgery, allows doctors to perform many types of complex procedures with more precision, flexibility and control than is possible with conventional techniques ( <i>Mayo Clinic Staff, 2021</i> ).
Spinal Surgery	Back surgery is a procedure that aims to change a patient's anatomy, such as removing a herniated disc that is causing pain, with the purpose of providing pain relief ( <i>Back Surgery Definition, 2021</i> ).
SHH	Surgic Hospital of 's-Hertogenbosch (SHH) located in 's-Hertogenbosch, the Netherlands.
Surgeon	A medical practitioner qualified to practise surgery.
Surgical Procedures	A medical procedure involving an incision with instruments; performed to repair damage or arrest disease in a living body.
Urogynecology	Urogynecology a specialized field of gynecology and obstetrics that deals with female pelvic medicine and reconstructive surgery.
Urology	The branch of medicine and physiology concerned with the function and disorders of the urinary system.
Vascular Surgery	Vascular surgery encompasses the diagnosis and comprehensive, longitudinal management of disorders of the arterial, venous, and lymphatic systems, exclusive of the intracranial and coronary arteries.

(*Oxford Learner's Dictionaries, 2021*)

#### 4. Process of Process Modelling

The process of process modelling is split into three phases. The conceptualizing phase, modelling phase and approval phase. Throughout these phases, various stakeholders at SHH will be supporting the SHH-BPM team. The BPM lifecycle consists of many stages.

In the process identification phase, reference models and early interviews should be used to gather information to form a process landscape diagram. In-depth interviews should then be carried out with domain experts. Questions should be asked surrounding the efficiency, health and importance of processes in the organization. An analysis can be performed to obtain a prioritized process hierarchy. From this hierarchy, the most importance processes to work on will be identified

and these will be the focus of the process discovery. SHH-BPM training classes will occur before this as a way of easing the SHH staff into being able to work effectively with the BPM changes that may be occurring. During these training classes, the business-area users set of guidelines for business-area users will be used.

In process discovery, the processes current inner-workings need to be uncovered. To gain this information, interviews, workshops and observations can be conducted:

- Workshops: Attempt to identify all of the stakeholders, and have a representative of each type of stakeholder present and have them all together so that over the course of a couple sessions, a reference point model can be modified to represent the current state of the process.
- Interviews: Performed one on one with an expert, where the information that an interviewee knows is given to the BPM-team. The expert will only know the information that they know about their part of the process, so a large quantity of interviews will need to be collated into a singular coherent model that combines what they said together. Different people may contradict each other, and assumptions will need to be made and then certain stakeholders reinterviewed in a cycle like process to establish exactly what the current process is.
- Automated process discovery can occur via the collection of information from systems in an organization, but the hospital doesn't have the required systems for this to occur.
- Observation: Watch how the process is done by follow directly the execution of individual process instances, then abstract from instance to process level. Unfortunately, this can then only be seen either from the customers perspective, which at a hospital is very difficult to do, or it can be done via observing the staff at the hospital, but they may react differently being watched and could also be distracted and make mistakes by your presence. In life or death situations such as surgery, having a bystander in the way can also be dangerous.

To model the information gathered from the stakeholder, the tools in the tools section will be used. Benefits of these tools are specified in that section. To accurately model the information, the stepwise method should be used. First, identify the process boundaries such as the triggers and outcomes, then identify activities and events that occur within the process. Once this has been completed, identify resources and their handovers by including message events. Identifying the control flow of the sequence flow can be done at this stage, but depending on the process may make sense to do throughout every stage if it helps the modeler understand their own model better. Identify additional elements such as data objects, different types of events and exception handling.

Once the information has been gathered and modelled using the BPMN, then it can go through the process of redesign via analysis to produce a model that is the process to be, this will need further clarification from the subject matter experts to see whether the new process is actually feasible and would improve the process. Once it has been approved, then the process model can be widely distributed and used by business-area users to implement the changes specified.

## 5. Governance Aspects

### 5.1 Stakeholders

The stakeholders involved in modelling is the project SHH-BPM team. Additionally, the IAB203 junior analysts' team is also involved to aid the SHH-BPM team with the initiative and have a strong focus on the process modelling components. The Hospital Board steering committee which consists of the director and four vice-directors, the heads of the 20 departments, the division heads of HR, Finance, IT, Asset Management and Patient Services are all key stakeholders as they are responsible for making the regulatory and organizational decisions for the SHH.

Business-area users

### 5.1.1 Roles and Responsibilities

Roles	Responsibilities
Senior Business Analysts	Perform and facilitate the BPM lifecycle including process identification, process discovery, process analysis, process redesign, process implementation, process monitoring and controlling. Perform upskilling of the staff. Managing and guiding the junior business analysts Doing performance checks and quality checks of the junior business analysts work.
Junior Business Analysts	Perform and facilitate the BPM lifecycle including process identification, process discovery, process analysis, process redesign, process implementation, process monitoring and controlling. Perform lower-level modelling tasks.
Hospital Board Steering Committee	Giving advice and creating decisions about changes as the project progresses and develops. Ensuring that the project delivery will ultimately result in the desired outcome of the project. Monitoring and identifying risks that could potentially hinder or result in a negative outcome to the SHH.
Process Owners	Accurately capture current processes by utilizing business process models. Monitor and identify possible areas of improvement. When possible, process owners will also carry out and execute process improvements in order to support the SHH-BPM team.
General Staff	The staff at the hospital are responsible for being active participants and act as the subject matter experts, giving information and insight to the SHH-BPM team.

### 5.2 Access, Ownership and Maintenance

All stakeholders will be provided access to the models created as soon as the process models have been reviewed and accepted by the hospital board steering committee. This will be done by having access to a central repository of the process models that are staff and public access, so that anyone can get access to the latest models at anytime for any reason. This document, with both sets of guidelines, will also be available to those within SHH in a central repository. Nonetheless, the creators of the models are the ones responsible of keeping the maintenance for their respective models and have their intellectual property covered by the SHH-BPM team. The BPM-team will have access to the models at any stage, except for when others are working on the same model via Signavio, where Signavio limits two users working on the same diagram. In this case, access will be granted by screen sharing the analysts screen to the other analyst so that they can work on the model collaboratively.

### 5.3 Process Taxonomy

The following is a list of terms and names that is used in BPM. These terms are used in the SHH-BPM team to discuss process modelling and the BPM lifecycle.

TERM	DESCRIPTION
Core Process	A core process is a process that generates value for the business as they are directly linked to the external customers
Management Process	A management process is a process that provides the direction, rules, and practices for all of the other processes in an organization
Support Process	A support process is a process that provides resources to be used by other processes, such as other support processes, core processes and management processes
Business Analyst	An BPM team member that uses BPM, BPM lifecycle and analysis the processes, to improve the processes, products, services, and software at an organization.
Rework	Rework is when a process loops back over the same activities again
Business Process	A chain of events, activities and decisions involving a number of actors and objects, triggered by an event and leading to an outcome that is of value to a customer.

BPM	Business Process Management is a discipline that uses the BPM lifecycle, process identification, process discovery, process analysis, process redesign, process implementation, process monitoring and controlling, to improve business processes.
Modelling Guidelines	Provide details to stakeholders and modelers to be able to understand, use and possibly model process models
Business Transformations	Business transformations are fundamental changes to the processes that an organization conducts. This can include the complete redesign or modification of existing processes and subsequent changes in personnel and technology used.
Process Landscape	A model which is of the highest level that shows the entire organization on a single page. All stakeholders in an organization should be able to look at the diagram and spot which group of processes their job is part of.
Process Hierarchy Levels	The levels of a process hierarchy are the different levels of abstraction in a process architecture. These can range from extremely low level, where the individual pieces of data and precise in-depth map of a part of single process that occurs at the subprocess level, all the way up to the process landscape that abstracts the entire organization onto a single page
Value Chain	Chain of processes an organization performs to deliver value to customers and stakeholders
Stakeholder	A member or the company or an interested party in the company that may have an influence, or be influenced by a business
BPM lifecycle	The BPM lifecycle is the process that occurs inside business process management. The process identification stage produces a process architecture diagram, process discovery produces the current as-is processes for the most important processes, process analysis

### 5.3 Tool Support and Governance of Process Modelling Repository

The tools that are used to create the model include the business process modelling software of Signavio. Signavio has a range of BPMN and value chain creation abilities. BPMN models that are created in Signavio can be automatically checked for syntax errors and will make recommendations for modelling conventions. There are multiple ways of performing role management on Signavio. Senior analysts will be able to add users to the BPM-team able to work on in-process models. They will also be able to grant commenting, editing, viewing and sharing access. LucidChart is also another application that is used for the creation of models, specifically the process architecture including the process landscape diagram. Similar to Signavio, Lucidchart has a range of role management mechanisms that can be implemented. The senior analysts will be able others to the BPM-team to be able to edit the models. Business-area users will be able to be added to comment, edit, view or share. Before access rights are given to an individual, whether internal or external to the BPM-team, a background check should be conducted and the reason for them being added needs to be directly stated and recorded. This is to prevent sabotage of BPM models. The central repository will be able to be edited by the BPM-team. The BPM-team will be able to move models and the guidelines to and from the archive in the repository to make sure that the latest versions of the models are presented to the business-area users. Updated models should be uploaded to the repository as soon as they are approved.

### 5.4 Communication Plan and Versions

All of the staff at SHH will be given access to a central repository containing up to date versions of the BPM models, most likely integrated with the new administration and computer software that will become available throughout the BPM initiatives. The appropriate staff will be given access to their respective set of modelling guidelines. The guidelines for the business-area users will be available to the business-area users. The guidelines will also be actively distributed via email before workshops, interviews and any other formal interaction with the BPM team, as attachments. The guidelines for the BPM-team will be available to the BPM-team. This is to avoid confusion for the business-area users, since a more complicated BPM guidelines that talk about modelling guidelines from the perspective of the BPM team. The BPM team

will obviously have access to the business-area user modelling guidelines since they will have to update the BPM modelling guidelines. This should be done on a regular basis, both on the initiative of the BPM team, as well as when there are complaints or suggestions from the business-area users. The newer versions of the modelling guidelines should replace the old ones, but the old ones should still be kept in the archives so that changes to the guidelines can be reverted if they turn out to be poor changes.

The BPM models should also be treated the same way. The SHH-BPM team will be able to modify the business process models and process architecture on their own initiative throughout the BPM lifecycle. Previous versions of the models should be kept in the archives so that changes can be reverted. The relevant process models will be distributed to the relevant business area users at different times, but always be available from the central repository. This distribution may occur in paper or butcher paper form, such as in an interview, approval session or workshop, or may be in electronic format, such as being given to a process owner so that they may distribute it to other staff that may need it for the process to be implemented.

### 5.5 Meta Data Maintenance Mechanisms

There should be many mechanisms that control the metadata of the process models and the modelling guidelines. The BPM models will have the creator of the model, creation date of the model, the current status of the model (whether it is a draft model, it has been approved or it is under review, the actual explicit version of the model, the title of the model and a short description. This may be present of the actual model itself, but this will only be the case in physical copies of the process models. In Signavio, the process models will have this information automatically stored in the data of the model, since Signavio will automatically store the creation date, those who edited the model and the title of the model. The current status will be added to the title of the model, as well as a version number. Short description of the model cannot be included in Signavio, but can be added as a comment on the model. In the central repository, all of this meta-data will be stored attached to the diagrams in the system. The "current status" will be a textual description underneath the model, as well as all the other meta-data surrounding the models. When models are distributed, the meta-data that is still attached to them will be altered. When a business-area user inspects a model, they will not have access to the status of the model if they are implementing the model since it is not relevant. The creation date of the model will also be irrelevant if the version number is present. The title of the model will always be available alongside the model. When the model is transposed into documents, the meta-data may be displayed around the model, such as the title of the model, the description of the model and the version of the model. However, the version and creation date of the model do not need to be included if the date and version of the document itself are present, unless the document contains two versions of the same document, in which case the model will need to have the version number written on or beside it.

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