### **Operations Management**

### Lecture 5: Business Process Modeling

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#### **Business Process Management**

Art and science of overseeing how work is performed in an organization to ensure consistent outcomes and to take advantage of improvement opportunities.

BPM is about managing entire chains of events, activities and decisions that add value to the organization and customers





## Typical examples of processes that can be found in most organizations include

Order-to-cash	Performed by a vendor, which starts when a customer submits an order and ends when the product or service in question has been delivered to the customer and the customer has made the corresponding payment.
Quote-to-order	It starts from the point when a supplier receives a Request for Quote (RFQ) from a customer and ends when the customer in question places a purchase order based on the received quote.
Procure-to-pay	Starts when someone in an organization determines that a given product or service needs to be purchased. It ends when the product or service has been delivered and paid for.
Issue-to-resolution	Starts when a customer raises a problem or issue, such as a complaint related to a defect in a product or an issue encountered when consuming a service
Application-to-approval	Starts when someone applies for a benefit or privilege and ends when the benefit or privilege in question is either granted or denied. This type of process is common in government agencies



### A process involves







# We can view BPM as a continuous cycle comprising the following phases:





#### **Process categories**







#### **Process architecture**

- Level 1 shows the company's value chains.
- Level 2 provides a decomposition for each business process in the value chains.
- Level 3 provides additional breakdown into subprocesses and tasks.





## **Process architecture:** Value chain models for sequence, decomposition, and specialization





#### **Process mapping**

**Process mapping** simply involves describing processes in terms of how the activities within the process relate to each other.

**Flowchart**  $\rightarrow$  picture of the separate steps of a process in sequential order, including materials or services entering or leaving the process (inputs and outputs), decisions that must be made, people who become involved, time involved at each step, and/or process measurements.

There are many techniques which can be used for process mapping

#### **Process Flowchart**

A drawing used to analyze movement of people or material. There are many different specific forms of the flowchart in use such as systems flowcharts or work methods flowcharts



Value Stream Mapping

Lean management method for analyzing the current state and designing a future state for the series of events that take a product or service from the beginning of the specific process until it reaches the customer.



#### Business Process Modeling Notation (BPMN)

A standard Business Process Model and Notation (BPMN) will provide businesses with the capability of understanding their internal business procedures in a graphical notation and will give organizations the ability to communicate these procedures in a standard manner.





#### **Process Flowchart**



#### Commonly used symbols in detailed flowcharts

One step in the process. The step is written inside the box. Usually, only one arrow goes out of the box.

Direction of flow from one step or decision to another.

Decision based on a question. The question is written in the diamond. More than one arrow goes out of the diamond, each one showing the direction the process takes for a given answer to the question. (Often the answers are "yes" and "no.")

Delay or wait

Link to another page or another flowchart. The same symbol on the other page indicates that the flow continues there.

Input or output

Document

Alternate symbols for start and end points



#### **Process Classification Framework (PCF)**

Cross Industry Process Classification Framework® (PCF) is a taxonomy of cross-functional business processes intended to allow the objective comparison of organizational performance within and among organizations.







### **Process Classification Framework (PCF)**

1.1.1       Assess the external environment (100         1.1.1       Identify competitors (19945         1.1.2       Analyze and evaluate comp         1.1.3       Identify conomic trends (11         1.1.4       Analyze and evaluate comp         1.1.5       Assess new technology inn         1.1.6       Analyze demographics (100         1.1.7       Identify political and regula         1.1.8       Identify social and cultural         1.1.9       Identify intellectual propert         1.1.10       Evaluate IP acquisition opti         1.1.2       Survey market and determine custome         (10018)       1.1.2.1         1.1.2.2       Capture customer needs an         1.1.2.3       Assess the internal environment (1001)         1.1.3.1       Analyze organizational char         1.1.3.2       Analyze internal operations         1.1.3.4       Analyze for and technic         1.1.3.5       Analyze for and technic         1.1.3.6       Identify core competencies	n vision (17040) [7] etition (10021) [002] 1.2.2.3 tory issues (10023) vations (10024) 25) 1.2.2.4 thanges (10026) 1.2.2.5 (10027) 1.2.2.6 (10027) 1.2.2.6 (10027) 1.2.2.7 r needs and wants 1.2.2.8 (10791) 1.2.2.7 r needs and wants 1.2.2.8 etitics (16790) 1.2.2.1 gative research and 1.2.2.1 d wants (19946) 1.2.4 towants (19947) 1.2.2.1 gative research and 1.2.2.1 d wants (19946) 1.2.4 towants (19947) 1.2.5 creater atteristics (10030) 1.2.3 Select (19948) 1.2.4 Coordi (10044) 1.2.5 Create Level 1 - Category Represents the highest level Level 2 - Process Group	1.2.2.1 Identify implications for key operating model business elements that require change (13289) 1.2.2.2 Identify implications for key technology aspects (13290) Develop B28 strategy (16800) 1.2.2.3. Develop service as a product strategy (16801) Develop pactner/alliance strategy (16803) Develop merger/demerger/acquisition/exit strategy (16805) Develop merger/demerger/acquisition/exit strategy (16806) Develop sustainability strategy (14806) Develop sustainability strategy (19806) Develop sustainability strategy (19950) 0 Develop sustainability strategy (19951) 1 Develop sustainability strategy (19951) 1 Develop innovation strategy and framework (19952) Iong-term business strategy (10039) nate and align functional and process strategies ) organizational design (10041) Evaluate breadth and depth of organizational structure (10049) Develop Vision and Strate I .0 Develop Vision and Strate	<ul> <li>2.1 Govern and manage product/service development program (1966)</li> <li>2.1.1 Manage product and service portfolio (10051)</li> <li>2.1.1.1 Evaluate performance of existing products/ services against market opportunities (10063)</li> <li>2.1.1.2 Confirm alignment of product/service concepts with business strategy (10066)</li> <li>2.1.3 Prioritize and select new product/service concepts (10074)</li> <li>2.1.1.4 Plan and develop cost and quality targets (10075)</li> <li>2.1.1.5 Specify development timing targets (10075)</li> <li>2.1.1.6 Plan for product/service offering modifications (10076)</li> <li>2.1.2 Inform product and service life cycle (10067)</li> <li>2.1.2 Develop plan for new product/service development and introduction/auch (16824)</li> <li>2.1.2.2 Introduce new product/services (10077)</li> <li>2.1.2.3 Retire outdated products/services (10078)</li> <li>2.1.2.5 Conduct post launch review (11423)</li> <li>2.1.2.5.1 Carry out post launch analytics to test the acceptability in the market (19646)</li> <li>2.1.2.5.3 Review effectiveness of supply chain and distribution network (11425)</li> <li>2.1.2.5.3 Review effectiveness of supply chain and distribution network (11425)</li> <li>2.1.2.5.3 Review effectiveness of supply chain and distribution network (11425)</li> <li>2.1.2.5.4 Apply data and analytics to review supply chain methodologies (19847)</li> </ul>	2.1.42 2.1.43 2.1.44 2.1.45 2.1.47 2.1.48 2.1.4.7 2.1.49 2.1.4.10 2.2.1 Perform 2.2.1.1 2.2.12 2.2.13 2.2.2 Generate 2.2.2.1 2.2.22 2.2.23 2.2.23 2.2.24 2.2.25	Manage bills of material (11742) Manage specifications (11744) Manage groduct/material classification (11746) Develop and maintain quality/inspection documents (11747) Maintain process specification data (11748) Manage traceability data (11749) Review and approve data access requests (11750) Identine new product/service ideas (19698) Iscover research (10065) Identify new technologies (10070) Develop new technologies (10070) Develop new technologies (10070) Assess fasability di intgrating new leading technologies into product/service concepts (10072) Review enduct/service ideas and requirements (19980) Famulate new product/service ideas and requirements (19988) Formulate new product/service concepts (19689) Identify potential improvements to existing products and services (10068)
	Level 2. Presses		(12202)		
	Level 3 - Process	1.1.5 Conduct organ	ization restructuring opportunities (16792)	**	
	A process is the next level of	of the decomposition after a process	group. This can include core elements needed	to	
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	accomplish the process as	well as element related to variants a	and rework.		

Tasks represent the next level of hierarchical decomposition after activities. Tasks are more fine grained and



### **SIPOC Diagram**

SIPOC (supplier, Input, Process, Output, Client) is a method for describing the process to be considered. It creates understanding about the customers of the process and can therefore be used as input for the VoC.

#### Steps

- 1. Define the process and its boundaries.
- 2. Identify the outputs of the process, including data, services, products, information, records, and so on.
- 3. For each identified output, identify all of the associated inputs.
- 4. Move on to the internal and external customers— those that receive the identified outputs.
- 5. Move back to the supplier column to identify the internal and external suppliers for each identified input.



### **SIPOC Diagram: Example**

Suppliers	Inputs	Process		Outputs	Customers		
Providers of the required inputs/resources to ensure that the process executes as planned.	Resources required by the process to obtain the intended output.	Top-level description of activity.		Deliverables from the process. Note: deliverables can be hardware, software, systems, services, data, information, and so on.	Any organization that receives an output or deliverable from the process. Note: can also capture systems/databases that receiv outputs, information, data, and so on.		
		Requirements		أدعا وحدود والتاريخ	Requirements		
Development team	S/W size estimating guide	S/W size estimation methods/formulas					
External customer/ program manager	<ul> <li>System specifications</li> <li>Prime item development specification</li> <li>System requirements doc</li> <li>And so on</li> </ul>	Total count of requirements allocated to S/W Preferred soft copy with requirements identified ("shall")	Customer requirements	New SLOC     Modified SLOC     Reused SLOC     Auto-generated SLOC	SLOC formatted for entry into price estimating software and organizational metrics collection system	Project/pursuit software lead	
S/W development leads of past and current projects	Legacy systems knowledge	Legacy SLOC data from project assessment library and organizational metrics	, <b>,</b>	Basis of estimate (BOE) for quote	Rational for SLOC estimates Information for fact finding	Proposal manager	
Organization subject matter experts	Identification of most applicable/similar legacy S/W	Determine scope of similarities (number of requirements new, modified, reused, or deleted)	Identify customer requirements impact to code Software lines of code (SLOC) estimate	Legacy code product information	Reused S/W development information • Documentation • Version • Qualification test/results • Standards (498, DO178B, and so on)	Proposal manager	



SIPOC\_PizzaSale



### **Business Process Modeling Notation (BPMN)**

A standard Business Process Model and Notation (BPMN) will provide businesses with the capability of understanding their internal business procedures in a graphical notation and will give organizations the ability to communicate these procedures in a standard manner. Furthermore, the graphical notation will facilitate the understanding of the performance collaborations and business transactions between the organizations. This will ensure that businesses will understand themselves and participants in their business and will enable organizations to adjust to new internal and B2B business circumstances quickly.





#### **BPMN 2.0:** Notation













### **Branching and merging:**

Activities and events may not necessarily be performed sequentially.

#### Gateway



The term gateway implies that there is a gating mechanism that either allows or disallows passage of tokens through the gateway.

As flow unites arrive at a gateway, they can be merged together on input, or split apart on output depending on the gateway type.



- Split gateway represents a point where the process flow diverges
- Join gateways represents a point where the process flow converges. Have multiple incoming sequence flows (representing the branches to be merged) and one outgoing sequence flow.



#### **Branching and merging : Exclusive decisions**

To model the relation between two or more alternative activities  $\rightarrow$  exclusive (XOR) split.

An **XOR-join** is used to merge two or more alternative branches that may have previously been forked with an XOR-split.





When splitting, it routes the sequence flow to exactly one of the outgoing branches. When merging, it awaits one incoming branch to complete before triggering the outgoing flow.



#### **Example 3: Exclusive decisions**

Consider de following invoice checking process.

As soon as an invoice is received from a customer, it needs to be checked for mismatches. The check may result in any of the following three options: (i) there are no mismatches, in which case the invoice is posted; (ii) there are mismatches but these can be corrected, in which case the invoice is resent to the customer; and (iii) there are mismatches but these cannot be corrected, in which case the invoice is parked and the process completes.





#### **Branching and merging: Parallel Execution**

When two or more activities do not have any order dependencies on each other they can be executed in parallel.

An **AND-split** is used to model the parallel execution of two or more branches

an **AND-join** is used to synchronize the execution of two or more parallel branches

#### Parallel Gateway



When used to split the sequence flow, all outgoing branches are activated simultaneously. When merging parallel branches it waits for all incoming branches to complete before triggering the outgoing flow.



### **Example 4:** Parallel Execution

Let us consider the security check at an airport.

Once the boarding pass has been received, passengers proceed to the security check. Here they need to pass the personal security screening and the luggage screening. Afterwards, they can proceed to the departure level.





# Example 5: A more elaborated version of the order-to-cash process diagram

Let us extend the order-to-cash example by assuming that a purchase order is only confirmed if the product is in stock, otherwise the process completes by rejecting the order. If the order is confirmed, the shipment address is received and the requested product is shipped while the invoice is emitted and the payment is received. Afterwards, the order is archived and the process completes.





#### **Branching and merging: Inclusive Decisions**

Sometimes we may need to take one or more branches after a decision activity

OR gate

**Inclusive decisions:** At a branch point, at least one flow is activated. At a convergence point, it waits for all flows that were activated to activate the outgoing



#### Inclusive Gateway

When splitting, one or more branches are activated. All active incoming branches must complete before merging.



### **Example 6: Inclusive Decisions**

A company has two warehouses that store different products: Amsterdam and Hamburg. When an order is received, it is distributed across these warehouses: if some of the relevant products are maintained in Amsterdam, a sub-order is sent there; likewise, if some relevant products are maintained in Hamburg, a sub-order is sent there. Afterwards, the order is registered and the process completes.







### **Example 6: Solution 2**





### Example 6: Modeling an inclusive decision with the OR gateway

To model situations where a decision may lead to one or more options being taken at the same time, we need to use an inclusive (OR) split gateway. An OR-split is similar to the XOR-split, but the conditions on its outgoing branches do not need to be mutually exclusive, i.e. more than one of them can be true at the same time.

When we encounter an OR-split, we thus take one or more branches depending on which conditions are true.





# Example 7: The order-to-cash process model with product manufacturing

Let us extend the order-to-cash process with the possibility of manufacturing products that are not in stock.





### **Example 8:** Rework and repetition

In the treasury minister's office, once a ministerial inquiry has been received, it is first registered into the system. Then the inquiry is investigated so that a ministerial response can be prepared. The finalization of a response includes the preparation of the response itself by the cabinet officer and the review of the response by the principal registrar. If the registrar does not approve the response, the latter needs to be prepared again by the cabinet officer for review. The process finishes only once the response has been approved.



#### **Business objects**

A business process relates to different organizational aspects such as functions, business objects, humans, and software systems.

- Functional perspective → indicates what activities should happen in the process
- Control-flow perspective → indicates when activities and events should occure
- Object perspective (data perspective)
   →indicates which business objects, also known as artifacts (e.g. documents, files, material) are required to perform an activity, and which ones are produced as a result of performing an activity.



A **Data Object** represents information flowing through the process, such as business documents, e-mails, or letters.

A **Collection Data Object r**epresents a collection of information, e.g., a list of order items.

A **Data Input** is an external input for the entire process. A kind of input parameter.



A **Data Association** is used to associate data elements to Activities, Processes and Global Tasks.



. . . . . . .

A **Data Store** is a place where the process can read or write data, e.g., a database or a filing cabinet. It persists beyond the lifetime of the process instance.



## **Example 9:** The order-to-cash example with data objects and data stores





**Resource perspective (organizational perspective)** → indicates who or what performs which activity

A resource can be:

- A process participant, i.e. an individual person like the employee John Smith,
- A software system, for example a server or a software application,
- A piece of equipment, such as a printer or a manufacturing plant.

Active resources

 resources that can autonomously perform an activity,

#### **Passive resources**

 resources that are merely involved in the performance of an activity.





## **Resources:** BPMN provides two constructs to model resource aspects: pools and lanes

- Pools → generally used to model resource clases
- Lanes → used to partition a pool into sub-clases or single resources



Pools (Participants) and Lanes represent responsibilities for activities in a process. A pool or a lane can be an organization, a role, or a system. Lanes subdivide pools or other lanes hierarchically.





#### **Example 10:** The order-to-cash example with resource information





## Example 11: Collaboration diagram between a seller, a customer, and two suppliers

### White box pool (private process)

it shows how the seller organization participates in the order-to-cash process in terms of activities, events, gateways and data objects.

### Black box pool (public process)

it hides how these organizations actually participate in the order to-cash process.





#### **Process decomposition**

A **sub-process** represents a self-contained, composite activity that can be broken down into smaller units of work.



To improve understandability, we can simplify the model by hiding certain parts within a sub-process !!



#### **Example 12:** Identifying sub-processes in the order-to-cash process





**Message events**  $\rightarrow$  capture the interaction between our process and another party regarding sending messages.

**Timer events**  $\rightarrow$  indicates that process instances start upon the occurrence of a specific event (e.g. every day at 7 a.m.)

**Racing events**  $\rightarrow$  two external events race against each other, the first event that occurs determines the flow of the process. This race between external events is captured by means of the event-based exclusive (XOR) split

<b>Events</b>	Start		Intermediate				End	
Lvents	Standard	Event Sub-Process Interrupting	Event Sub-Process Non-Interrupting	Catching	Boundary Interrupting	Boundary Non- Interrupting	Throwing	Standard
None: Untyped events, indicate start point, state changes or final states.	$\bigcirc$			       			0	Ο
Message: Receiving and sending messages.		$\square$	$(\bigcirc)$	$\bigcirc$	$\bigcirc$	Ô		
Timer: Cyclic timer events, points in time, time spans or timeouts.	$\bigcirc$		Ô	O	O	Ð,		
Escalation: Escalating to an higher level of responsibility.		$\bigcirc$	$(\widehat{\mathbb{A}})$		$\otimes$	$\langle \widehat{\otimes} \rangle$	$\bigotimes$	$\oslash$
Conditional: Reacting to changed business conditions or integrating business rules.								
Link: Off-page connectors. Two corresponding link events equal a sequence flow.				$\bigcirc$			igodol	
Error: Catching or throwing named errors.	     	$\bigotimes$	1	1	$\oslash$			$\oslash$
Cancel: Reacting to cancelled transactions or triggering cancellation.				       	$\otimes$			$\otimes$
Compensation: Handling or triggering compensation.	     			     			$\bigcirc$	€
Signal: Signalling across differ- ent processes. A signal thrown can be caught multiple times.	$\bigcirc$	$\bigcirc$	$(\widehat{\bigtriangleup})$	$\bigcirc$	$\bigcirc$			٢
Multiple: Catching one out of a set of events. Throwing all events defined	$\bigcirc$	$\bigcirc$	$(\bigcirc)$	$\bigcirc$	$\bigcirc$		$\bigcirc$	$\bigcirc$
Parallel Multiple: Catching all out of a set of parallel events.	€	Ð	()	€	€	(Ð)		
Terminate: Triggering the immediate termination of a process.			     	     	     	   		$\bigcirc$



#### **Example 13: Message Events**





#### **Example 14:** Timer events

Let us consider the following process at a small claims tribunal.

In a small claims tribunal, callovers occur once a month to set down the matter for the upcoming trials. The process for setting up a callover starts three weeks prior to the callover day with the preparation of the callover list containing information such as contact details of the involved parties and estimated hearing date. One week prior to the callover, the involved parties are contacted to determine if they are all ready to go to trial. If this is the case, the callover is set, otherwise it is deferred to the next available slot. Finally on the callover day, the callover material is prepared and the callover is held.





## Example 15: A race condition between an incoming message and a timer





#### **Process redesign: Process Optimization**





#### **Process redesign:** The Business Model Canvas





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