Università degli Studi di Trieste

Corso di Laurea Magistrale in
INGEGNERIA CLINICA

LA MODELLAZIONE DEI PROCESSI IN MEDICINA

Corso di Informatica Medica

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PROCESS MODELING

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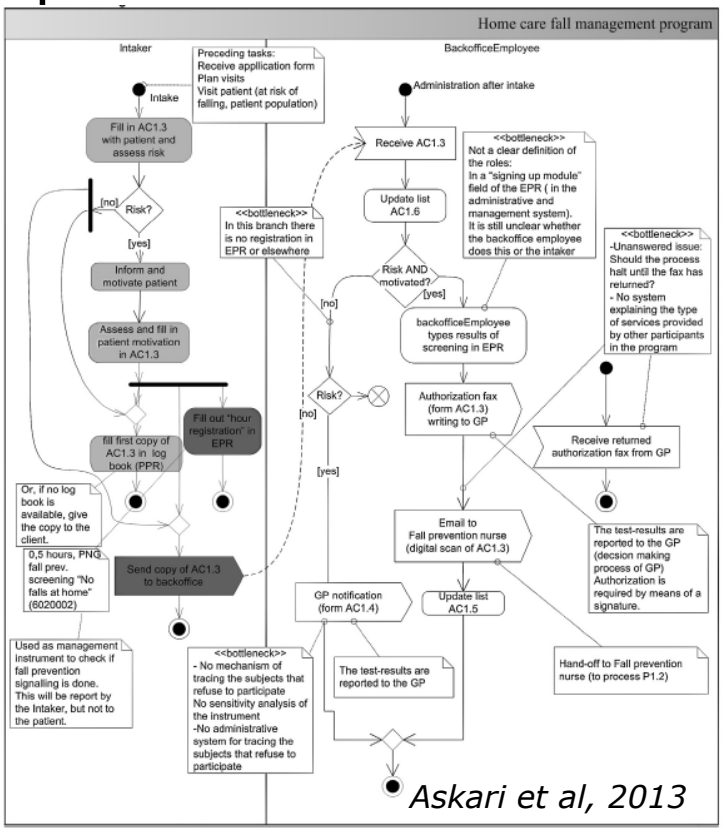
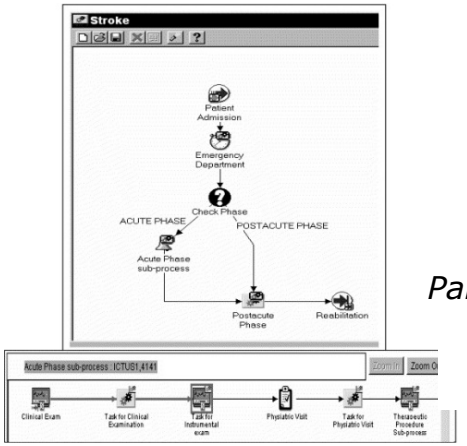
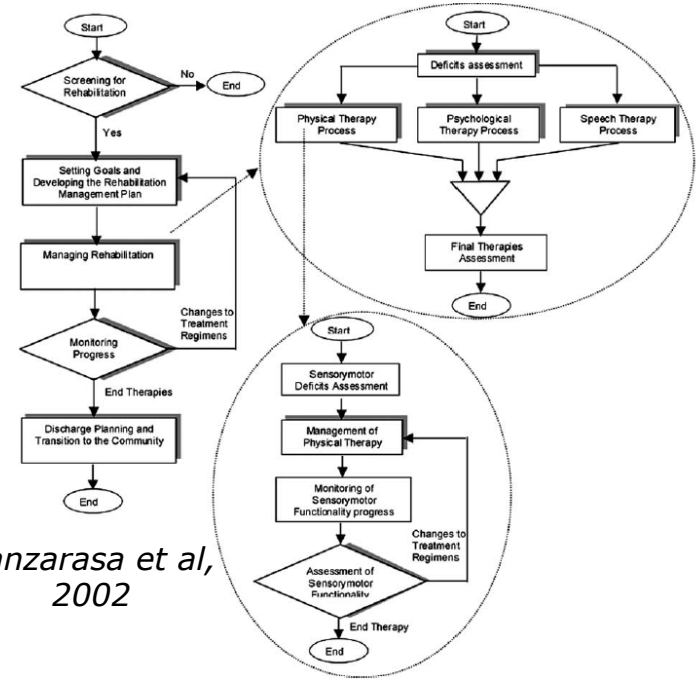
Model → abstraction used to represent and describe the process under examination



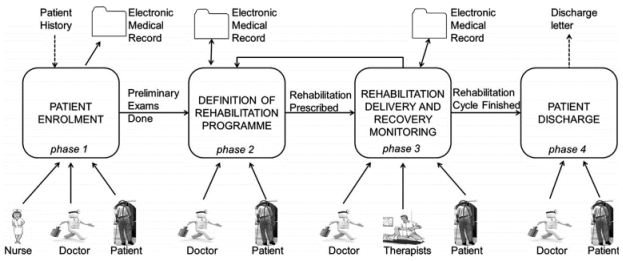
Askari et al, 2013



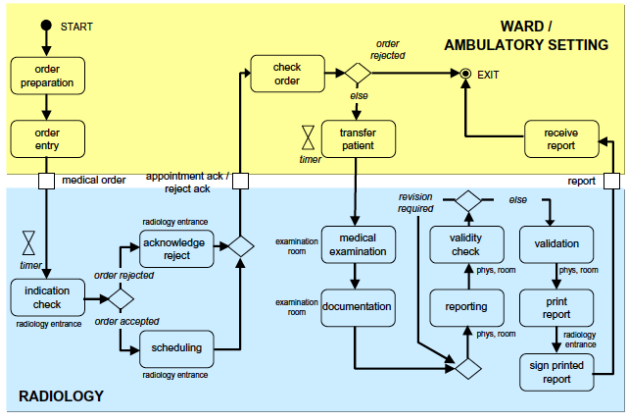
Quaglini et al, 2001



Panzarasa et al, 2002



Ferrante et al, 2013



Lenz & Reichert, 2007

HEALTHCARE PROCESSES

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Multiple stakeholders

Patient's response to treatment

Patient's engagement

Multiple systems

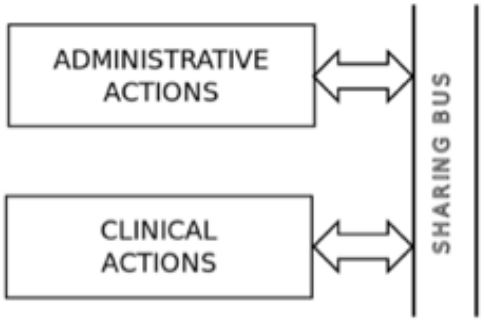
COMPLEXITY

Patient's empowerment

Evolving knowledge

Multiple action domains

Evidence based practices



COMPLEXITY AND TRANSPARENCY: CLINICAL ISSUES

DOMAIN	FEATURE	ISSUE
Medical knowledge	Evidence based medicine, guidelines, recommendations	Dynamic Evolution of medical evidence-based knowledge
	Local practices	Flexibility to include the local context
	Clinician's personal experience, habits and skills	Multiple stakeholders interaction
	Learning by practice	Learning curves that interfere with timing
	Building evidence from practice	Process mining with big data analysis
Personalization and Response to treatment	Time - immediate response or long-term response	Uncertainty
	Compliance - depending on patient's engagement	Indeterminacy
	Expected outcomes	Definition of outcome variables
	Patient's feedback to treatment	Uncertainty due to patient's reported outcome measures
	Patient-centric approach	Exceptions and Flexibility

COMPLEXITY AND TRANSPARENCY: ORGANIZATIONAL ISSUES

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	DOMAIN FEATURE	ISSUE
Systems and infrastructures	Data exchange among different systems	Technological Interoperability
	Introduction of local IT infrastructural constraints	Flexibility to include local context
	Compliance with standards	Technological Interoperability
Actors	Related actions, multiple profiles executing the same task	Multiple responsibilities Transparency
	Data access	Data Protection
	Domain knowledge of the specific profile	Semantic Interoperability

EXPECTATIONS FROM HEALTHCARE PROCESS MODELING

CLINICAL EXPECTATIONS

- Establishing shared protocols for patient's care.
- Facilitating adherence to the shared protocols, thus limiting problems due to incomplete communication or misunderstandings among different actors, ultimately increasing patient's safety.
- Monitoring deviances from the protocols, redundancies, and failures, thus early identifying problems that could lead to un-prevented errors.

ORGANIZATIONAL AND TECHNOLOGICAL EXPECTATIONS

- Fully understanding the information flow, thus identifying requirements and specifications for information system re-engineering and interoperability.
- Detecting process weaknesses thus designing corrective measures.
- Optimizing the use of resources.

RESULTS OF PROCESS MODELING: e-PRESCRIBING

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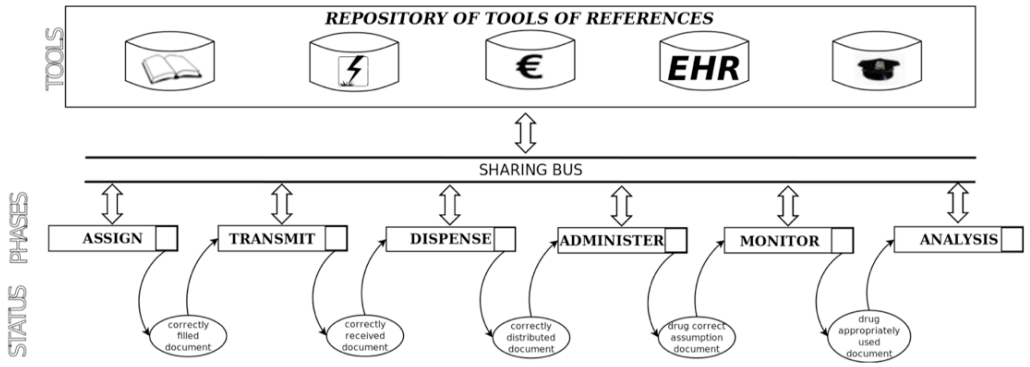
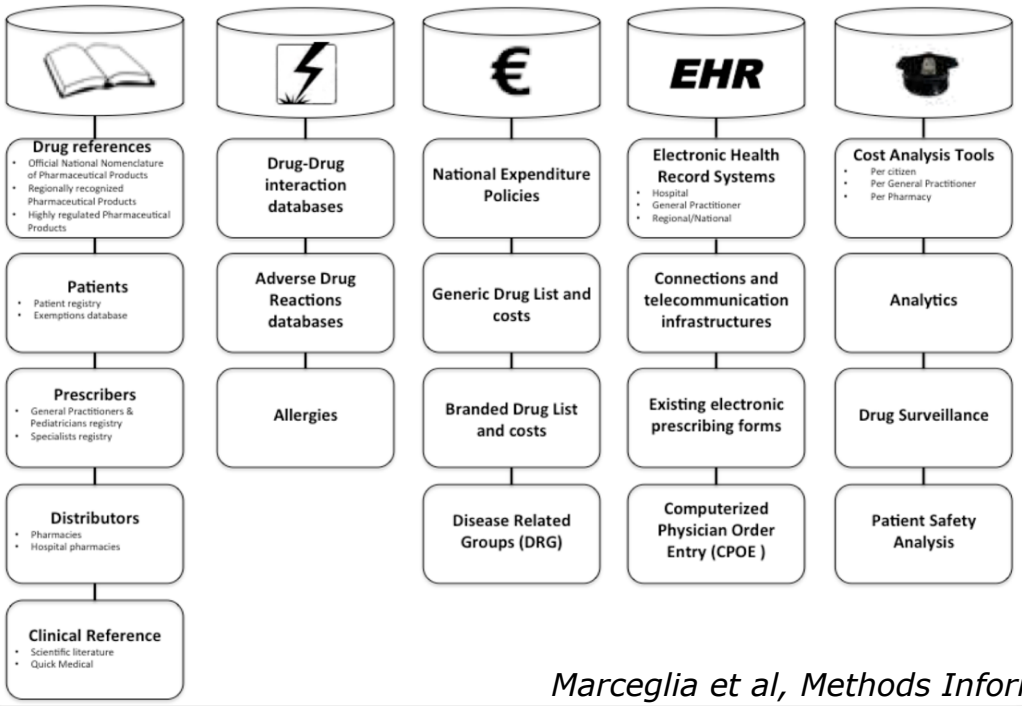
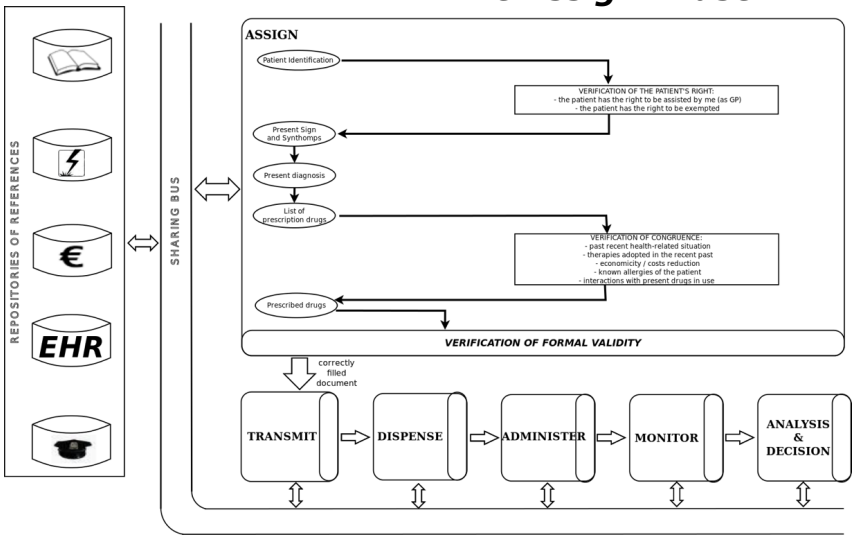
b) The overall e-prescribing system



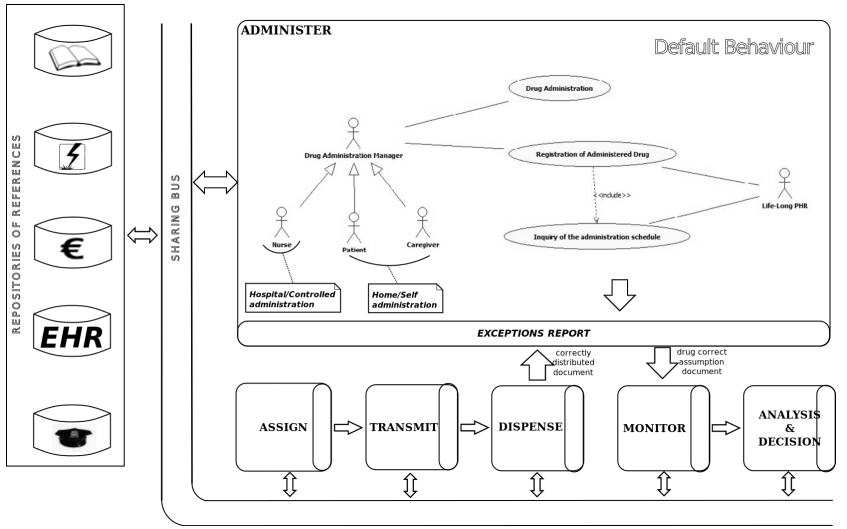
c) Detailed tools



The Assign Phase



The Administer Phase



Marceglia et al, Methods Inform Med, 2013

RESULTS OF PROCESS MODELING: e-PRESCRIBING (2)

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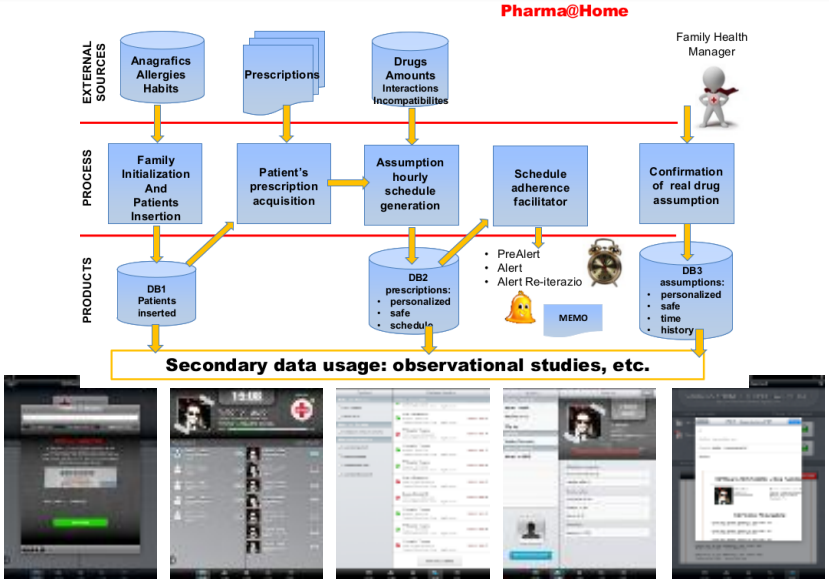
UNDERSTANDING WHAT IS NEEDED

- None of the e-prescribing systems studied manages the drug administration phase → new tools for the safe and monitored drug administration at home
- Only one e-prescribing system provides some support during prescription → new systems to integrate drug references and drug-drug interactions for GPs

EVALUATING BENEFITS AND COMPARING EXISTING SYSTEMS

- If a phase of the e-prescribing process is completed according to the model, there are benefits for the healthcare system → Quality, Efficiency, Access
- Implemented systems can be represented through the modelled functionalities → comparing the functionalities can be translated into comparing the benefits



Verification actions \ Benefits	Quality	Access	Efficiency
Assign			
Valid patient	Identity error avoided	Ensures patient's existence within the National Healthcare System	Avoided time waste due to erroneous patient's identification
Valid exemptions rights		Ensures that the patient has the right of an exemption	Possibility to analyze the relationship between a prescribed drug and a certain exemption, thus preventing possible frauds.
Filled out diagnosis	Ensures that the prescription is the result of a new/previous diagnosis		Possibility to track the relationship between the diagnosis and a specific drug
Valid drug			Ensures that the drug is included in the official national nomenclature Avoided time waste due to non-existent drug
Drug-drug interaction check	Decreased risk of interactions with drugs already in use by the patient		Possibility to have a more efficient system of ADEs and drug-drug interaction reporting
Coherence between SPC and diagnosis	Decreased risk of incorrect drug assignment		
Valid GP identification			Ensures that the GP is recognized by the healthcare system as having the right to prescribe
Completely filled out prescription	Ensures that all the information needed also for continuity of care are provided		

Marceglia et al., Methods Inform Med, 2013

RESULTS OF PROCESS MODELING: ONCOLOGY

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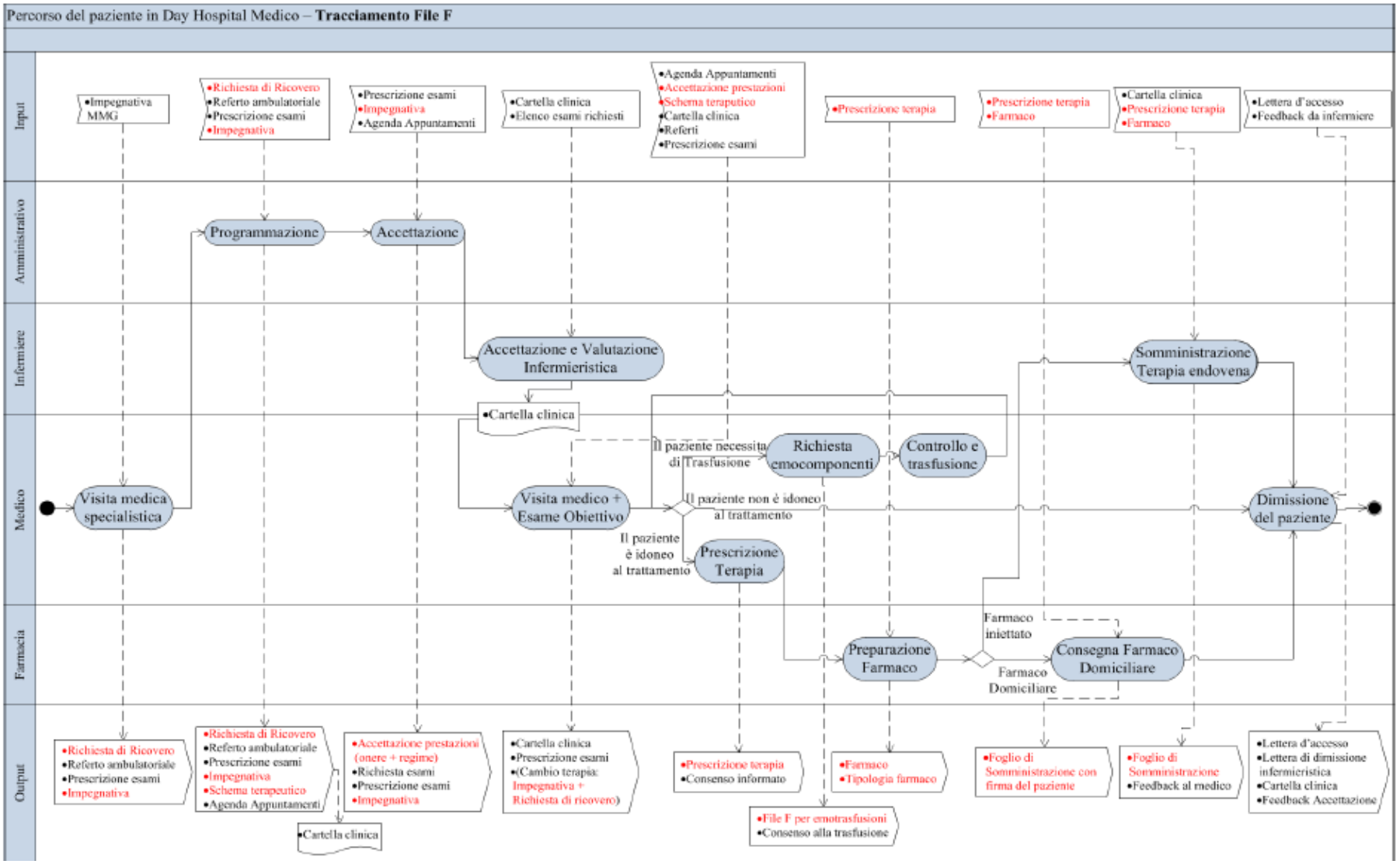
IEO Istituto Europeo di Oncologia

The ambulatory unit provides pharmacological anticancer therapy and supportive therapy to oncological patients



RESULTS OF PROCESS MODELING: ONCOLOGY

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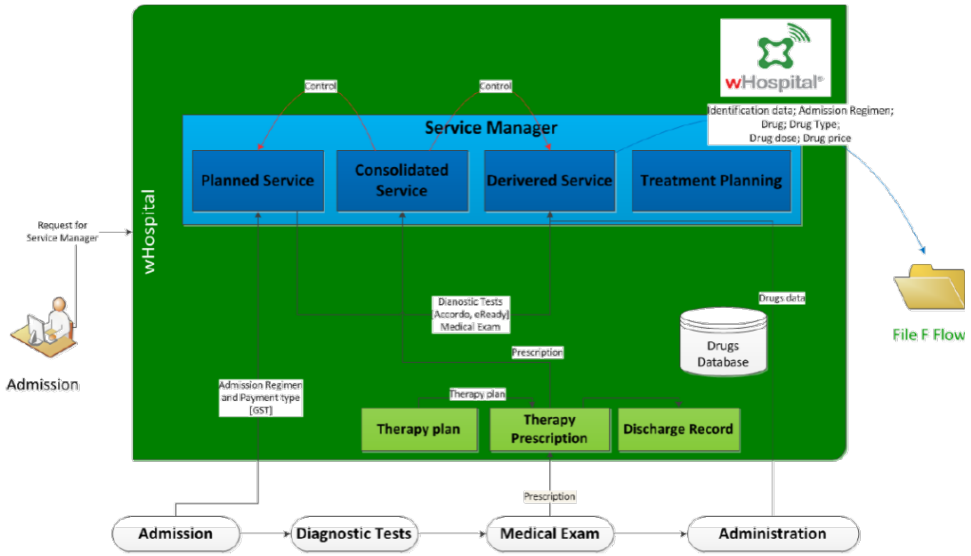
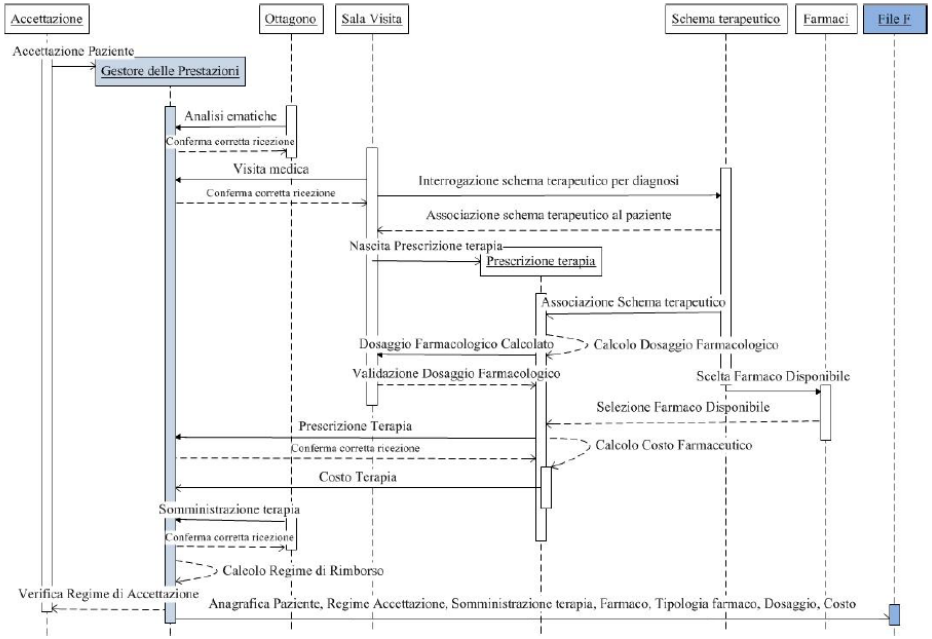
LOCAL LEVEL

- Definition of the specifications for a new module of the hospital information system able to manage the information loss during the ambulatory process

TRANSLATIONAL LEVEL

- Definition and representation of the care pathway of the oncologic patient during ambulatory anticancer therapy can be used in other oncologic settings





RESULTS OF PROCESS MODELING: INTEGRATED HOMECARE

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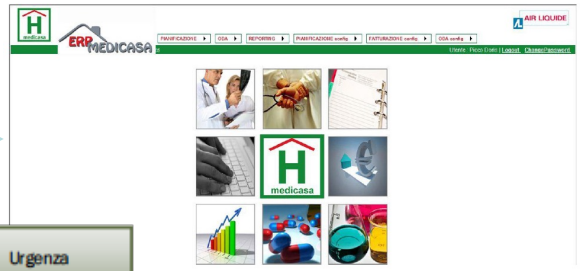
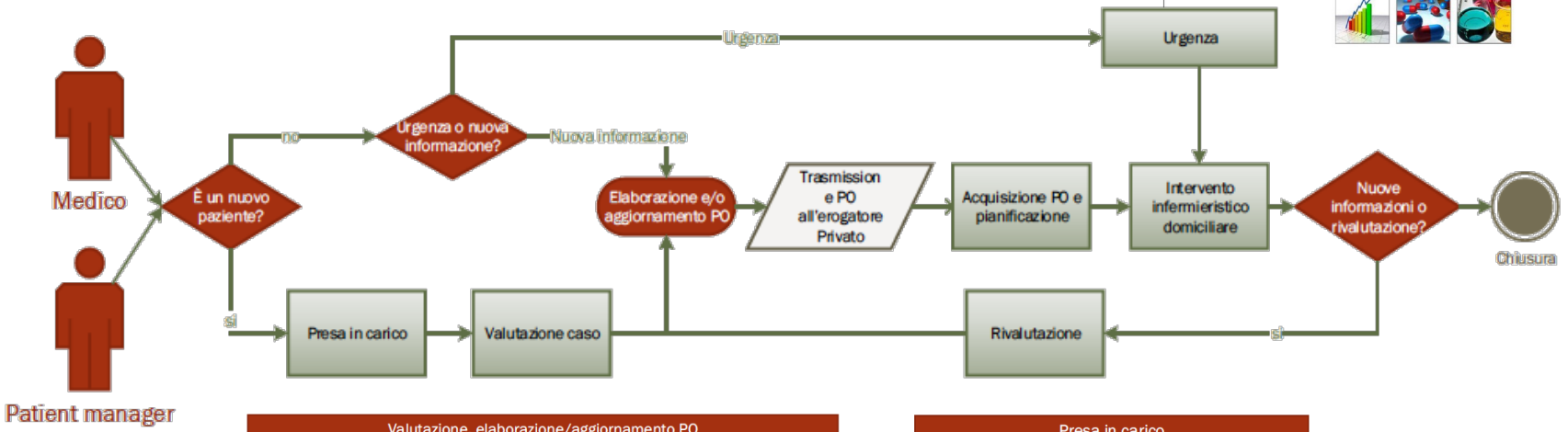
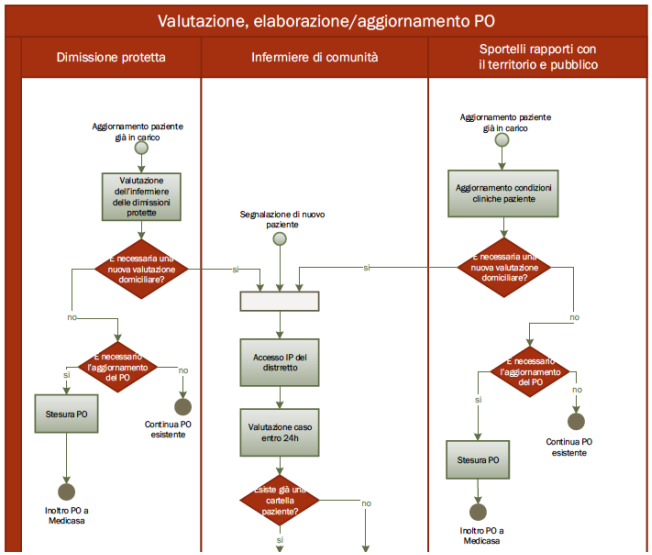
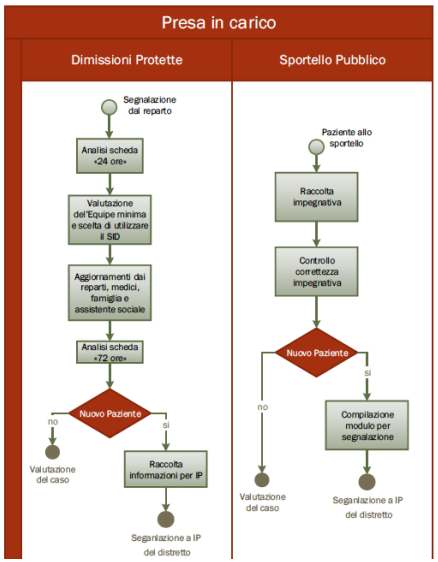
Azienda per i Servizi Sanitari n°4 Medio Friuli
Regione Autonoma Friuli Venezia Giulia

Homecare services for residents (care, palliative care, rehabilitation)









RESULTS OF PROCESS MODELING: INTEGRATED HOMECARE

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TRANSPARENCY

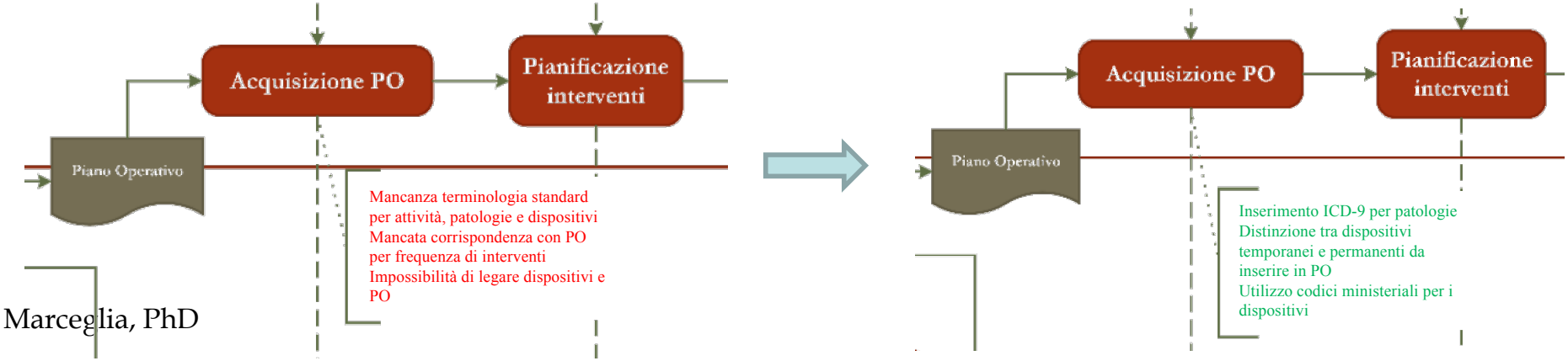
- The whole process of integrated homecare in the specific environmental setting was fully evaluated
- All the health information systems for patient's data collection and management were analyzed in terms of functionalities and information processed

PROCESS EVALUATION

- The most critical issues in the process were identified
- The redundancies and duplications of information across different systems were mapped

PROCESS OPTIMIZATION

- Possible solutions to the critical issues were identified and introduced in the model
- The model can be used to define measures of the efficiency of the service represented



MODELING METHODOLOGY OVERVIEW

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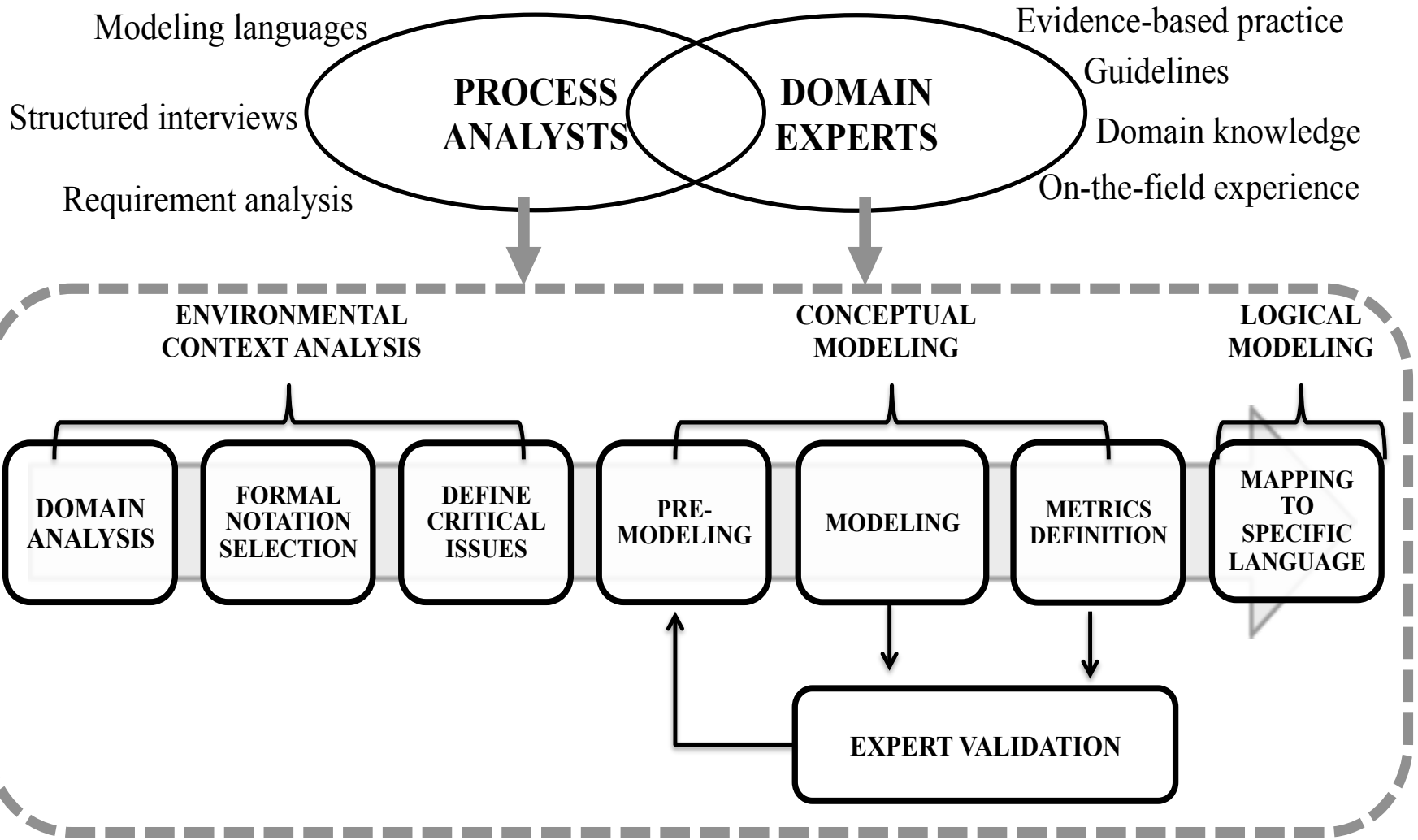

DOMAIN ANALYSIS

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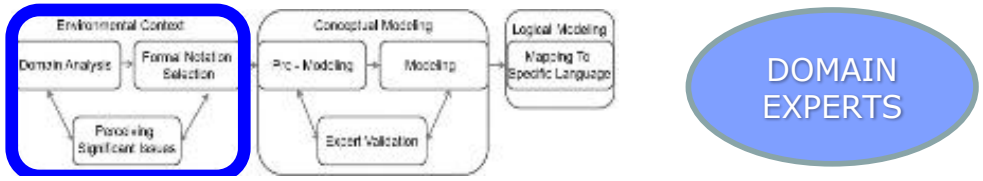
- Identifying and analyzing the available sources of information to fully understand the domain of interest
- Evidence-based knowledge → international guidelines and recommendations
- Local domain →
  - local practices
  - specific clinical pathways already in use locally
  - focus groups and interviews to the medical staff and/or the patient/caregivers, to highlight the personal experience of the actors involved in the process
- Description of the information systems already in use → helps planning the model deployment in the real everyday practice.



SELECTION OF THE FORMAL NOTATION: UML

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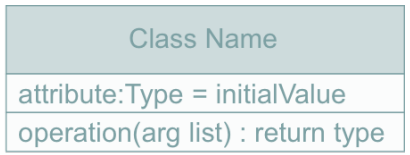
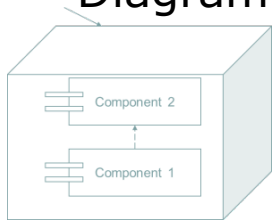
"The Unified Modeling Language (UML) is a graphical language for specifying, visualizing, constructing, and documenting the artifacts of software systems, as well as for business modeling and other non-software systems".

STATIC VIEWS

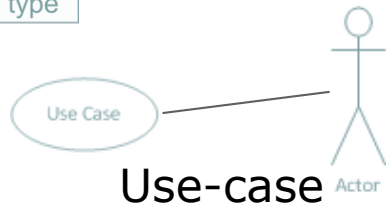
DYNAMIC VIEWS



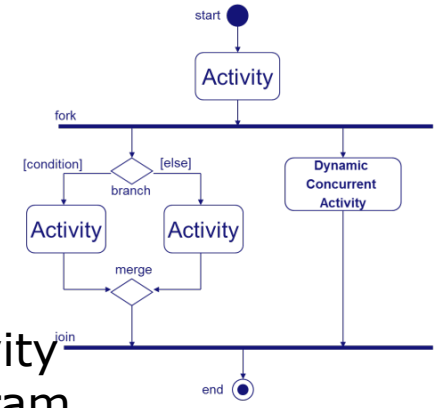
Class Diagram



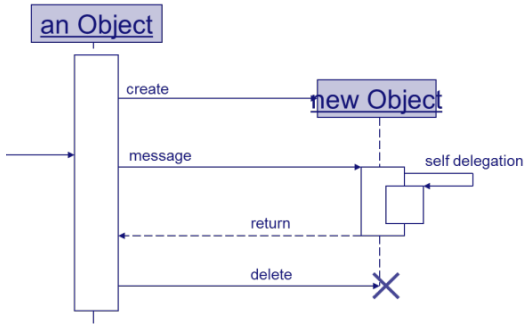
Component Diagram



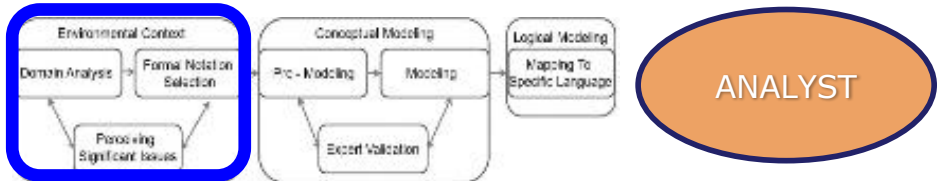
Use-case Diagram



Activity Diagram



Sequence Diagram



UML: ADVANTAGES

- Graphical language →
  - Enables the communication between domain experts and analysts
  - Easy to understand by non-experts of computer sciences
- Provides different views on the process→
  - Static and dynamic diagrams
  - Structural, Behavioural, and Interaction diagrams

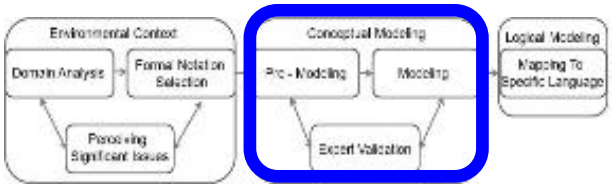
- The final UML model can be used as specification for the development of an IT system
- The use of UML promotes modularity and facilitates future changes
- It allows the evaluation of the whole system, also at the deployment level

PRE-MODELING

- Provide a high-level process description (process phases)
  - Functional aspects (main activities of the process, objects and data items managed)
  - Organizational aspects (agents, roles, skills, availabilities, authorizations required to enact the process) understand actors' responsibilities on the main activities business aspects (goals to be achieved).

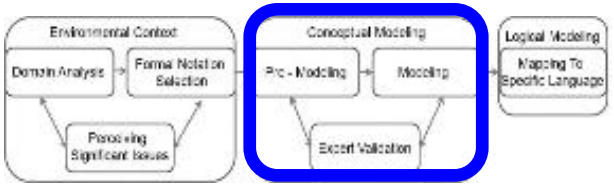
- Define a list of goals of the process modeling effort

- Identification of outcomes and integration with patient-reported outcome measures



MODELING

- The modeling step starts from the previously collected information and produces a conceptual model of the process according to the formal notation adopted
- The conceptual model comprises:
  - the schema of the process
  - its variables
  - the specification of the expected exceptions
  - the specification of the transactions
  - the access control model
  - the description of the interactions with the external information system.
- The results of the modeling are then validated by the domain experts, before continuing with the design



MODEL EVALUATION

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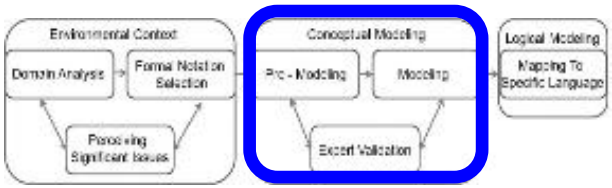
Assess if the model is "syntactically correct"

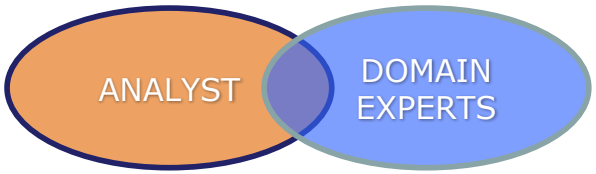
- Verify the internal consistency of the model.
- Assess its usability as a starting point for the logical modeling towards the software implementation.

Assess if the model is "semantically correct"

- Iterative approach based on focus groups or external validators.
- Analysis by actor type to validate the flow of information in the simplest activities of the process.
- Analysis with multiple actors to test the whole model.
- The model is final when a total agreement between experts and analysts is reached.

Askari et al. 2013





METRICS AND GQM

- METRIC = a quantitative measure of the degree to which a system, component, or process possesses a given attribute
- Metrics for the evaluation of health ITs cannot be directly derived from the model itself → the model can be the basis for identifying the outcome variables to be introduced into e-management techniques as metrics for evaluation.
- Goal Question Metrics (GQM) →
  - allows selecting metrics with a top-down and goal-oriented approach
  - the identification of the metrics starts from the definition of goals
  - The definition of the goals is done during the conceptual modeling phase
- GQM has three levels →
  - Goal: Conceptual level, defines the main purposes of a work to be measured;
  - Question: Operational level, defines a set of questions useful for achieving the goals;
  - Metric: Quantitative level, defines a set of metrics for answering the questions in a measurable way.

MODEL IMPLEMENTATION

- Mapping to a specific executable language
- Building a system implementing the model
- Create new modules of an already existing system to implement the process