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Domains of Health IT and Tailoring of Evaluation: Practicing Process Modeling for Multi-Stakeholder Benefits

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Abstract. This contribution focuses on the heterogeneity and complexity of health information technology services and systems in a multi-stakeholder environment. We propose the perspective of process modeling as a method to break out complexity, represent heterogeneity, and provide tailored evaluation and optimization of health IT systems and services. Two case studies are presented to show how process modeling is needed to fully understand the information flow, thus identifying requirements and specifications for information system re-engineering and interoperability; detect process weaknesses thus designing corrective measures; define metrics as a mean to evaluate and ensure system quality; and optimize the use of resources.

Keywords. Process assessment (health care), complexity, flexibility, electronic prescribing.

1. Complexity of healthcare and its impact on health-IT design and evaluation

Our journey for being and staying healthy is complex [1], is life-long, involves multiple actors to cover our different needs, and, as with many other aspects of our life, is now supported by technology. Or this is what we expect.

However, the concept of complexity should be defined more precisely: heterogeneous action sub-domains, dynamic evolution of knowledge, learning curves, indeterminacy, uncertainty, exceptions, transparency, and data protection are some of the features contributing to the concept of complexity that deserve some consideration [2].

In healthcare, two sub-domains of actions, the clinical sub-domain (devoted to patient care) and the administrative domain (devoted to the economic and financial aspects of care) share the same information regarding the patient, but need different views that focus on the specific data. For instance, in prescribing pharmacological treatments to patients, the active component, beneficial effects, side effects, adverse

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events, and drug-drug interaction are clinically relevant to identify the prescribed drug, whereas the costs and reimbursement levels are relevant from the administrative viewpoint [3].

The dynamic evolution of medical knowledge implies that any health IT system aimed at supporting medical decision-making not only has to deal with the available evidence-based medicine, but also has to be ready to dynamically and flexibly include new relevant evidence that may arise, personal experiences [4] and learning curves (i.e., learning by practice) [5].

In addition, uncertainty and indeterminacy [6] mainly arise from (1) the patient's compliance and response to treatment that depend on the ability of patients to follow the instructions, their level of engagement, and health literacy; and (2) the ability of the patient to report the outcomes or complications of a treatment or therapy thus affecting the interpretation and judgment of the healthcare professionals responsible for it [7]. Also, the patient-centric approach in the design and development of health IT systems requires a level of personalization that may introduce "exceptions" and "deviations" from available clinical guidelines and recommendations, thus introducing another layer of "complexity".

Finally, the need of cooperation among different actors or roles within the patient/citizen care pathway [8] is translated into the need for a clear definition of roles, profiles, data views, and actions allowed, that could be summarized with the term "transparency".

All the features that we discussed so far show that the intrinsic complexity of the whole healthcare domain cannot be avoided and needs to be uncovered when designing, developing, and evaluating effective health IT systems and services.

2. Heterogeneity of Health IT: Multiple systems and multiple actors

The complexity of the healthcare domain is reflected in health IT systems that provide the technological support to the whole healthcare journey which is not limited to the periods when we are "patients", but it spans across our whole life, with different needs. We therefore need to distinguish between the "citizen" who is not a patient until she/he receives a diagnosis, and the "patient" who suffers from a disease (with possible comorbidities).

The classical healthcare pathway, that starts from prevention, until the patient receives a diagnosis, and then a treatment (or rehabilitation), can be seen from the two perspectives of the "patient" and the "citizen". The citizen is the main actor in the prevention phase, but still contributes to the healthcare journey when involved as caregiver. Similarly, the patient is more active in the last two phases but also participates in the prevention phase, either to keep her/his pathology under control, or to avoid comorbidities.

In this promising scenario, the patient and the citizen, despite being the main characters, are only two of the actors involved. Table 1 shows an attempt to represent the available health IT systems and services according to their main user profiles and the phase of the personal healthcare pathway. Whereas patients and families/caregivers have tools for all phases, the citizen is not considered as an active user profile in the treatment or rehabilitation phase. Other stakeholders are healthcare professionals and providers, the payers (public/private/insurances), and also students and researchers. Of course, for students and researchers, the tools are not specific for a phase of the

healthcare pathway but cover all of them. Even though not exhaustive, Table 1 depicts a heterogeneous environment, in which patient's and citizen's health depends on the intervention of different stakeholders who mainly need to collect relevant information regarding the patient's/citizen's conditions to take the right decisions.

Table 1. Examples of health IT systems classified according to the main final user (rows) and the phase of the healthcare processes (columns).

	Prevention	**Diagnosis**	**Treatment and Rehabilitation**
Citizens	Diet monitoring Exercise monitoring Educational tools Personal Health Record (PHR)	Communication with healthcare professionals Unsupervised symptom checkers e-services for checking symptoms Health information websites/apps	
Patients	Telemonitoring & Sensors Environmental monitoring Educational tools Personal Health Record (PHR)	e-services for checking symptoms Telediagnosis tools Portals for ranking/finding physicians	Drug tracking systems Telerehabilitation systems Patient portals
Family/Caregivers	Activity trackers Educational tools	Communication with healthcare professionals	Drug tracking systems Telerehabilitation systems Community support tools Family Health Records
Healthcare Professionals and hospitals/care centres	Risk assessment tools Screening and Telescreening Decision Support Systems Electronic Health Record (EHR)	Electronic Health Record (EHR) Supervised Symptom checkers Decision Support Systems Domain Ontologies and Knowledge representation systems Hospital Information System Reference databanks Biosignal/Bioimage Databanks	Telecare systems Computer Interpretable Guidelines (CIGs) and Recommendations Electronic Health Record (EHR) Social care records and supporting systems Reference databanks
Private/Public/insurance Payers	Insurance-provided PHRs Risk assessment	Health Information Systems	Telecare systems
Medical Students	Visual knowledge tools Bioimage databanks Online reference systems Virtual environments		
Researchers	Clinical report Forms (CRF) Shared Databanks Multicentre research platforms Reference databanks Crowdsourcing tools		

The number of different actors involved, the various levels of digitalization in different healthcare organizations, the processes implemented within these organizations, as well as their privacy and security policies and issues, contribute to create a scattered and heterogeneous scenario, in which information systems manage heterogeneous, and often redundant, information, with poor inter-communication,

caused by a lack of interoperability. This argues the need for appropriate tools able to break out such complexity thus providing tailored and effective evaluations and to follow the patient or citizen in a longitudinal, life-long, integrated perspective [9]. A process modeling approach provides such tools.

3. Breaking out complexity and representing heterogeneity to provide tailored evaluation: the process modeling perspective

Being an abstract representation of a process under examination, a model provides a clear representation of the actors, the roles, their tasks, their actions and resources, and tracks the information flow and the core phases throughout the process [10]. Hence, a model provides a clear and "transparent" view, in which all the complex features of the process are represented and analysed.

Process modeling can be used both in the design phase of health IT systems, especially when the model is represented using standard languages for software design (e.g., the Unified Modeling Language, UML), and in the evaluation and re-engineering phase. In fact, the reliable, shared, transparent, and multi-level description of the process underlying the health IT system facilitates (1) the understanding of how a system works and how it can be integrated with other systems operating within the same process, and (2) the application of standard-based solutions. This ultimately supports interoperability and integration among different health IT systems [8] by:

- *Representing the impact of the single IT system* on the process itself, thus providing an evaluation of the benefits introduced with the use of the system and its limitations
- *Comparing different IT systems*, to establish which system better fits specific needs, in a given setting with specific constraints, in order to choose the most appropriate solution
- *Simulating the use of the IT system in another setting*, by changing the local constraints and evaluating its possible impacts and effectiveness in different environments.

The most important clinical benefits of the application of process modeling to health ITs are creating shared protocols based on clinical guidelines and local practices and monitoring the adherence to them; facilitating the communication among different actors and roles all contributing to patient's care; highlighting process weaknesses and suggesting the applicable corrective measures; providing a clear view on the use and optimization of resources; fully understanding the information flow; and identifying requirements and specifications for information system re-engineering to promote interoperability [11].

Finally, models are usually represented in a graphical way that facilitates their sharing among the different actors involved, even though not expert in technologies and modeling. This implies that their multiple viewpoints can be involved in the evaluation (or design) of a system/service, thus enlarging the evaluation scenario and including the heterogeneous expertise, needs, and aims.

4. Basic principles of process modeling

The integration between the skills and knowledge of domain experts and analysts is essential to model a healthcare process (Figure 1). Domain experts provide the experience on the field, and are aware of the existence of clinical guidelines and evidence-based practices related to the specific process. On the other hand, analysts are able to translate the experiences and knowledge of domain experts in a model, and from it to extract requirements and evaluation criteria.

4.1. Basic steps

The general approach to process modeling for health ITs is composed of three phases (Figure 1) - the analysis of the environmental context, the conceptual modeling, and the logical modeling. They are described as follows:

1. *The analysis of the environmental context* includes the identification and analysis of the available sources of information (also evidence-based knowledge, international guidelines, and recommendations) and the understanding of the local domain in terms of local practices, and specific clinical pathways already in use locally. Focus groups and interviews with the medical staff or of the patient and caregivers highlight the personal experience of the actors involved in the process. This phase includes the analysis of the flow of information that is managed by the health IT system or service and its interaction (or need of interaction) with other existing systems, which is crucial to understand whether the data/information transmitted through the system under study is effectively used and received, and helps identifying the possible flaws. As part of this phase there is also the selection of the formal modeling notation (language, as, for example, the Unified Modeling Language – UML [12] or the Business Process Modeling Notation – BPMN [13]).

2. *The conceptual modeling* includes a pre-modeling and a modeling phase. During pre-modeling it is important to provide a high-level process description (process phases) in terms of functional aspects (main activities of the process, objects and data items managed), organizational aspects (agents, roles, tasks, skills, availabilities, authorizations required to enact the process), actors' responsibilities on the main activities, and business aspects (goals to be achieved). Outcomes have to be identified at this time, too. They can be either clinical outcomes (for example to evaluate a telemonitoring system) or functional or efficiency outcomes (for example to evaluate a booking system). The modeling phase produces the conceptual model of the process according to the formal notation adopted and comprises: the schema of the process with its variables, the specification of the expected exceptions and transactions, the access control model, and the representation of the information flow with external information systems. Thanks to the definition of the model, it is at this stage possible to define appropriate metrics, either to evaluate the process itself or to monitor the health IT service/tool that supports/implements the process. Domain experts act as feedback during the whole phase, to validate the model under construction. The validation, in fact, should not only verify whether the model is "syntactically" correct (internal consistency and usability

for system requirements definition), but also if it is "semantically" correct (validation of the information flow in the simplest activities of the process, and verification of the expectations of all the actors involved).

3. *The logical modeling* is the final phase in which the model is implemented either in an executable modeling language, or as a full system (or system modules). In this phase it is important to design the possible solutions to the critical issues identified, or to highlight the requirements for system re-engineering [11].

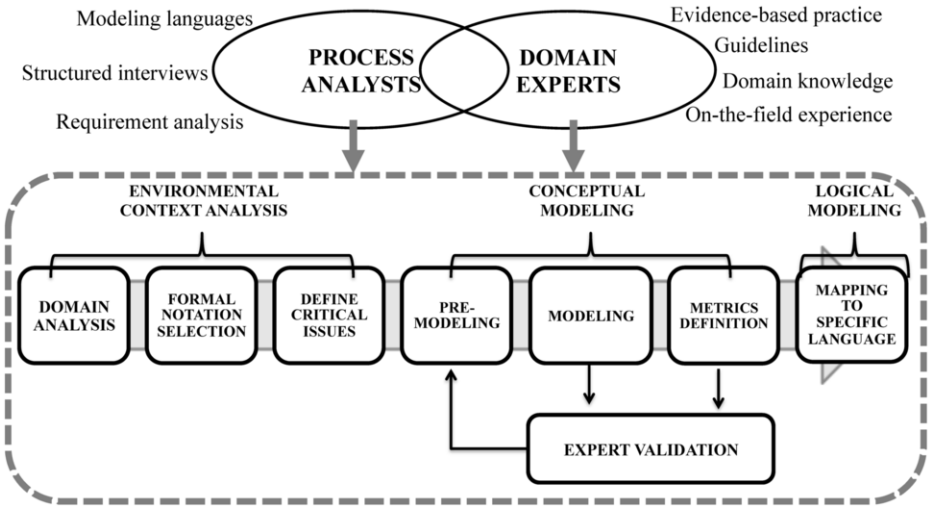

Figure 1. Basic modeling principles.

4.2. Metrics and process evaluation

A Metric is defined as "a quantitative measure of the degree to which a system, component, or process possesses a given attribute" [14] and it is based upon two or more measures. Metrics for the evaluation of health IT cannot be directly derived from the model itself. Models do not provide a direct means for cost-effectiveness or cost-benefit analysis. However, the model can be the basis for identifying the outcome variables to be introduced into e-management techniques as metrics for evaluation.

Moreover, as aforementioned, in order to deal with the overall heterogeneity of the healthcare processes and its stakeholders, not only metrics related to the economic factors must be considered. Health Technology Assessment (HTA) can represent a valuable approach for evaluating the single health IT system and for comparing it with different systems, since the HTA is a multidisciplinary and multidimensional approach for analyzing all the areas of interest (e.g. epidemiological, economic, social, ethical,

legal, organizational, and political implication) [15] [2]. Nevertheless, HTA is not always supported by structured techniques for the evaluation and prioritization (i.e., multiple-criteria decision analysis, such as the Analytic Hierarchy Process - AHP [16]).

Besides the prioritization and evaluation of the overall health IT systems, the processes behind it need to be monitored identifying the best metrics, and the proper time when they need to be measured for process evaluation. Indeed, the major regulations and directives for hospital accreditation and certification (e.g., Joint Commission International, ISO 9001:2008) require to define and model processes, and to identify the most appropriate performance measures (where performance measurement is defined as "a system for assessing performance of development interventions against stated goals" [17]) that can be organized in metrics. Nevertheless, they do not always specify *how* to define and collect performance measures and, consequently, metrics.

On the other hand, the application of process improvement techniques is rapidly growing in the healthcare context, and approaches originally linked to manufacturing areas (i.e., Lean Management) are being recently extended also to hospitals. Lean Management techniques suggest metrics for evaluating a process and its wastes (the "Lean Key Performance Metrics"), such as On-Time Delivery, Customer Lead Time Reduction, Inventory Turns, and Overall Efficiency Percentage Gains. Nevertheless, some of these metrics lack a unique definition, especially in the healthcare context.

Another technique for identifying metrics of interest that overcomes the limitations described above, is the Goal Question Metrics (GQM) [18]. The GQM allows selecting metrics with a top-down and goal-oriented approach, and it can be exploited for gathering the measurement data and driving decision-making and improvements, providing a support for the identification of the metrics starting from the definition of goals. The definition of the goals during the initial conceptual modeling of the process facilitates the implementation of the GQM. Specifically, the GQM can be divided into 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). The GQM is a versatile approach and can be considered a useful technique for defining metrics of health IT.

5. Case studies

This section presents two case studies, chosen to instantiate the considerations discussed in the previous parts of this contribution. The first case study looks at the use of process modeling to represent e-prescribing systems, providing a model-based evaluation framework able to identify the aims and needs of different systems, and to identify the gaps that require re-engineering [3].

The second case study shows the evaluation of the system for managing the pathway for cancer patients. Process modeling in this case was able to highlight an information loss in the ambulatory setting that does not impact the clinical outcome of the patients but the treatment reimbursement (administrative perspective, unpublished

[2] See also: P. Doupi, Evolving Health IT systems evaluation: the convergence of health informatics and HTA, in: E. Ammenwerth, M. Rigby (eds.), Evidence-Based Health Informatics, Stud Health Technol Inform 222, IOS Press, Amsterdam, 2016.

research), and led to the development of a new module of the hospital information system able to manage the information loss during the day care process.

5.1. Model-based representation of e-prescribing systems

E-prescribing is a complex process that differs from the simplistic idea of "transmitting a digital prescription to the pharmacy" [19]. It is a closed-loop process that starts from the decision of which treatment to prescribe to the patient and ends with the patient's clinical outcomes, with adverse events and clinical outcomes as feedback variables [19]. Heterogeneous e-prescribing systems are available worldwide, with different aims, in different contexts, and processing different information. This varied scenario claims for a reliable framework for the representation of different e-prescribing systems and for the evaluation of the benefits associated to their introduction [3].

For this reason, in cooperation with the Italian Government and in the framework of the Italian digitalization program for the Public Administrations entities (DigitPA), the modeling approach was applied to the e-prescribing process in order to (1) understand the possible benefits gained by the introduction of an e-prescribing system, and (2) compare existing e-prescribing solutions in terms of benefits for the healthcare system.

The modeling steps reported in Figure 1 were followed to create the e-prescribing model described in [3]: after the environmental context phase, which included also the direct interaction with the Italian Ministry of Health, the conceptual modeling phase provided the high-level meta-model (activity diagram), the identification of the interacting systems and tools, the definition of the expected outputs from each activity, and the definition of the evaluation outcomes in terms of expected benefits (Figure 2). For details about the model, see [3].

The evaluation framework was based on the verification of the correct implementation of specific functions that were called "verification actions". In each phase of the process, the model defines these "verification actions" that guarantee a specific benefit, with a fine granularity. For example, during the first phase of the process (i.e., Assign phase, when the treatment is prescribed to the patient, Figure 2A), if the e-prescribing system verifies the existence of a coded diagnosis in the prescription document, we can expect two kinds of benefits: (1) that the drug is assigned with a valid clinical reason (quality of care dimension, increased patient's safety), and (2) that the relationship drug-diagnosis is tracked and can be used for drug surveillance (efficiency of care dimension). In a similar way, if the e-prescribing system guarantees the verification of drug-drug interactions, we can expect a decreased risk of undesired adverse drug events (ADEs) or altered outcomes due to the interaction of the prescribed drug with others already in use (quality of care dimension). For the full description of each verification action and its expected benefit, see [3].

Aimed at providing a framework for evaluating and comparing e-prescribing systems, the modeling effort ended at this point. So, the presence/absence of model elements (i.e., verification actions) was used to compare the potential benefits introduced by three e-prescribing systems, namely the Lombardy Region (Italy), the Andalusia Region (Spain), and the Italian Government. The analysis, that is fully reported in [3], showed that all systems lack the connection between the first three phases (from "assign" to "delivery") and the administration phase, when the patient is at home, thus suggesting that the available e-prescribing systems fail in integrating the

patient as an active user and lose important information on drug administration and effect monitoring.

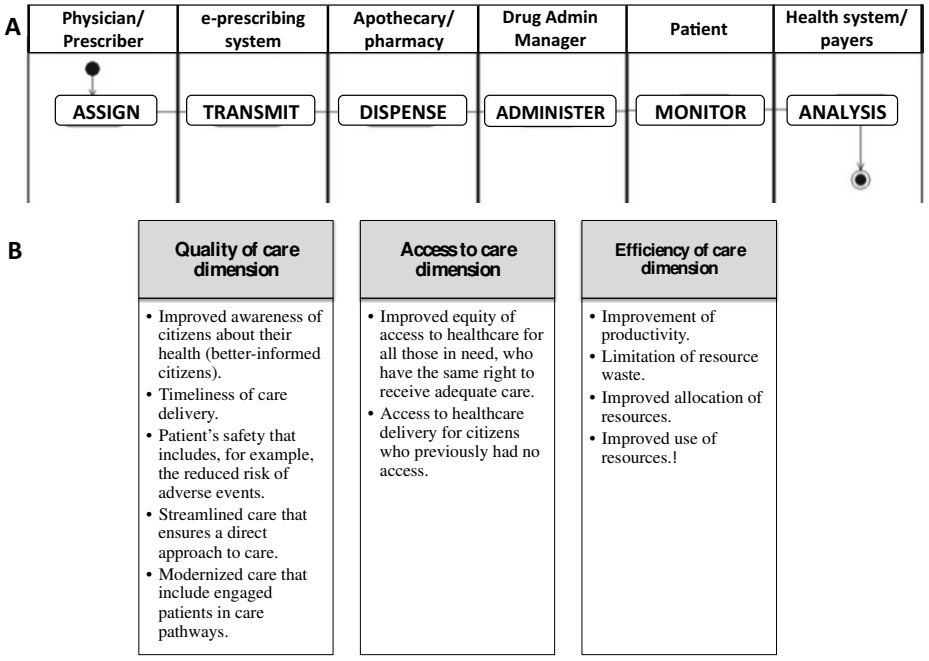

Figure 2. (A) High-level meta-model representing the main process phases.
(B) Expected benefits dimensions from the adoption of e-prescribing (adapted from [3]).

However, the model as it is also represents the basis for metrics definition, as a mean to ensure system quality. As an example, we can consider the "verification actions" identified by the model for the first process phase ("assign phase"). Each of them is associated with a set of benefits that, in terms of GQM (as explained above), which we can consider as the goals identified by the model that require metrics definition.

Table 2 presents a proposal of numeric metrics that can be used to evaluate the quality of both the e-prescribing system under examination and the e-prescribing process itself. For instance, in the case of "drug-drug interactions check", the benefit measure can be the number of reported ADEs before and after the adoption of the e-prescribing system under examination; in the case of "summary of product characteristics and diagnosis" the adopted metrics can be the number (or %) of prescriptions with reported diagnosis/drug pair in accordance with indications that not only show whether the e-prescribing system is able to support the assignment of drugs according to guidelines but also helps identifying cases of drug misuse.

Table 2. E-prescribing assign phase: verification actions, their associated benefits and metrics.

VERIFICATION ACTIONS IN THE ASSIGN PHASE	BENEFITS FOR QUALITY OF CARE	BENEFITS FOR ACCESS TO CARE	BENEFITS FOR EFFICIENCY OF CARE	POSSIBLE METRICS
Valid patient (patient validation)	Identity error avoided	Ensures patient's existence within the National Healthcare System	Avoided time waste due to erroneous patient's identification	Number (or %) of prescriptions with incorrect, missed or unknown patient ID
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.	Number (or %) of prescriptions with: - Invalid exemption code - Invalid patient ID/exemption code pair - Invalid exemption code /drug code pair
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	Number (or %) of prescriptions with: - Diagnosis reported - Correctly coded diagnosis reported
Valid drug			Ensures that the drug is included in the official national nomenclature Avoided time waste due to non-existent drug	Number (or %) of prescriptions with valid drug code % of generic drug prescribed vs branded drugs
Drug-drug interaction check	Decreased risk of interactions with drugs already in use by the patient		Possibility to have a more efficient alerting system of drug-drug interactions and ADEs reporting	Number (or %) of prescriptions avoiding drug-drug interactions Number of reported ADEs Number of new ADEs identified
Coherence between summary of product characteristics and diagnosis	Decreased risk of incorrect drug assignment			Number (or %) of prescriptions with reported diagnosis/drug pair in accordance with indications
Valid GP identification			Ensures that the GP is recognized by the healthcare system as having the right to prescribe	Number (or %) of prescriptions with unknown or missed GP ID

In conclusion, in this first case study, the analysis through a process modeling approach was able to (1) highlight what is still missing in existing systems (new tools for the safe and monitored drug administration at home connected to the e-prescribing systems) and (2) evaluating e-prescribing systems and processes by associating metrics to the modelled "verification actions" that represent the goals of e-prescribing in terms of benefits for the healthcare system.

5.2. Health IT systems for supporting the chemotherapy care pathway for cancer patients

Chemotherapy (CHT) is a crucial component of protocol-based care for cancer patients [20]. The process of prescription, preparation (dose calculation), and administration of

CHT is complex, because of the high toxicity of drug, and impacts on patient safety [21]. Errors may be caused by an inappropriate therapy prescribed or delivered, the presence of drug-drug interactions, or an incorrect dosage. Errors may also impact on cancer therapy costs that have been increasing dramatically over the last few years, and, consequently, on the economic sustainability of patient's management for healthcare institutions [22]. The patient's pathway within the hospital (the European Institute of Oncology (EIO), Milan, Italy) is supported by different health IT systems usually included in the hospital information system. However, the development of reliable health IT systems, capable to ensure proper management on the process and to prevent errors, is heavily grounded on the understanding of the underlying process.

The modeling effort, in this case study, aimed to (1) to describe the care pathway involving cancer patients receiving chemotherapies or supportive therapies at the Day Care division for the EIO, and (2) to highlight the critical aspects of the care pathway and, at the same time, to provide possible solutions for them.

The modeling methodology is summarized in Figure 3.

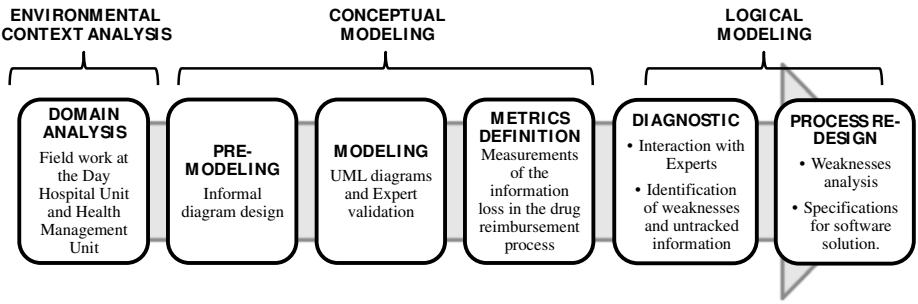

Figure 3. Modeling steps for the evaluation of the chemotherapy care pathways for cancer patients.

The first phase, the Analysis of Environmental Context, mainly consisted of field work, and lasted three months during which clinical and administrative practices, locally applied, were observed in presence (with attention to the clinical records pathway and information technology used). During the Conceptual Modeling, a high-level meta-model (pre-modeling) was used to identify the main activities, their sub-activities, and exceptions. The pre-model was then designed and validated during meetings with medical experts and administrative staff, during which misalignments with the proposed guidelines were also evaluated. The modeling phase involved the creation of UML structural and behavioural diagrams that were again validated both syntactically by the analyst experts and semantically by domain experts. The logical modeling phase, in this case, involved the "Critical Issues Identification", consisting of an analysis of each activity, represented on diagrams, that allowed highlighting process inefficiencies and their causes. From these, solutions that may allow a process reengineering, able to adapt the new models to the ongoing processes, were identified.

The model-based analysis identified the drugs reimbursement flow (called "File F flow") as one of the most critical processes in the patient's pathway. The main observed critical issues were associated with untracked information within the pathway (Figure 4). In fact, the pathway starts with the patient who has a prescription for chemotherapy and is admitted to the ambulatory process. The prescription is used to categorize the patient for the admission regimen and to define the level of reimbursement associated to the patient, and registered in the "file F". However, after

the first tests done by the nurse and the medical exam done by the oncologist specialist, the patient can be assigned to a therapy different from the one prescribed but more suitable for his/her current condition. This can affect the reimbursement and, in turn, the "file F flow". The conceptual modeling of the process currently implemented highlighted other information loss in the "file F" tracking: the difference between the admission regiment and the prescription, the loss of paper-based documentations for reimbursement request, and the loss of drug information for reimbursement after patient's visit. The process, in fact, didn't track the decision-making during the patient's visit (due to the lack of an appropriate information system) and the documentation running in the patient's pathway was not updated after establishing the patient's condition. This produced the lack of association between Reimbursement Rules (in the patient's electronic health record) and Administered Therapy (in a different paper-based record), and, in turn, no drug reimbursement for the hospital.

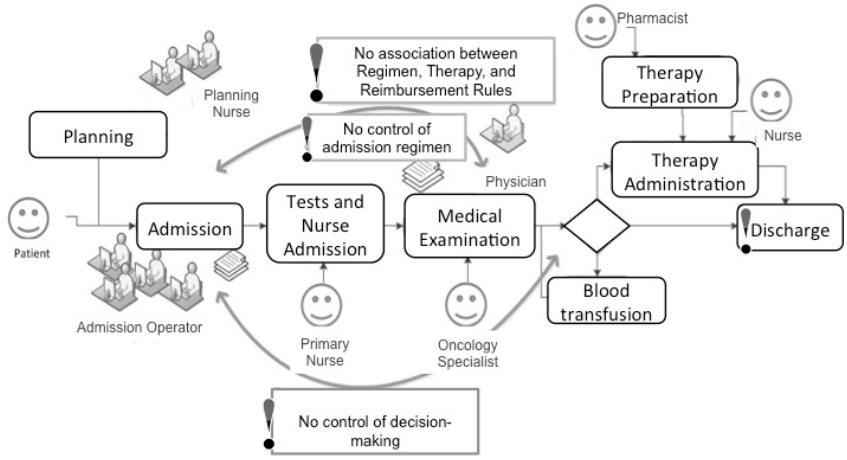

Figure 4. Pre-modeling: high-level UML-like activity diagram representing the care pathway with critical issues identified. Smileys represent process actors; sketches represent the interaction of actors with the available information systems.

Based on these considerations, a new model was created as a solution for the critical issues. The new model provided the technical specifications for the creation of a new module of the hospital information system that allows monitoring and controlling process variables, promoting operator coordination and integration, and optimizing the collaboration between operating units.

The goal of modeling in this case study was to limit the information loss for the drug reimbursement process. Also in this case, it is possible to identify metrics to evaluate whether or not the proposed solution satisfied such expectation. They can be, for example:

- the number of inconsistencies between the expected reimbursements and the obtained reimbursement;
- the number of incomplete "file F" for the patients treated.

In conclusion, in this case study, the modeling effort was able to provide a full representation of the complex process of the chemotherapy care pathway for cancer patients (with a translational value for hospitals other than the EIO), allowed the identification of the main critical issues underlying process inefficiencies and the

creation of a feasible solution to the identified critical issues, and grounded the definition of metrics to evaluate the efficiency of the proposed solution.

6. Conclusions

This contribution presented the heterogeneity and complexity of health IT services and systems that are a consequence of the heterogeneity and complexity characterizing the healthcare domain. We proposed the perspective of process modeling as a method to break out complexity and represent heterogeneity and to provide tailored evaluation and optimization of health IT systems and services. Process modeling not only provides a way to effectively represent the requirements of a system or service. By also supporting the identification of goals and benefits, it allows the definition of quantitative metrics able to show whether a system is suitable for a specific context, also in terms of economic revenue/savings [23].

Recommended further readings

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Food for thought

1. To what extent is modeling needed for defining metrics?
2. Is the personalization of care only a matter of exceptions to a generic model, or is it a specialization of a general model? How do we map personalization when modeling is done for requirement analysis?
3. Is process modeling able to represent the local environment without losing its generalizability? How can we ensure that models are portable in different environments?
4. Does a model designed for a specific context have a predictive value in establishing metrics for specific contexts for which the model has not been specialized yet?

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