Journal of Network and Innovative Computing.
ISSN 2160-2174 Volume 10 (2022) pp. 043–050

Business Process Model and Notation Implemented in The Hospital, Any Use? Case of the Patient Clinical Workflow

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Abstract: **A hospital is a complex organism covering simultaneously multiple interactions and operations, also different actors perform different activities and tasks that require a level of organization. For this reason, the whole situation in the hospital is represented by what we call the Patient's Clinical Workflow. In previous research, we proposed a business process model of the patient's clinical workflow in oncology to contribute to the intelligent digital transformation in Morocco. In this paper, We extended the previous finding and analyzed the patient's clinical workflow of the oncology service, in order to establish a base for the mandatory laws and proceedings, regarding the organization of the digital hospitals in the country. The explanations covered in the current paper will also contribute to the understanding of the clinical workflow in certain services within the oncology facility, namely the complex ones, where the operations are more relying on paperwork.**
Keywords: BPMN , Patient Clinical Workflow, Digital Transformation, Hospital Information System, Oncology

I. Introduction

Humanity went through a successive number of outstanding innovations that changed the shape of the world, mostly in healthcare, among these innovations, healthcare information technologies are considered as foremost tools for improving healthcare quality and safety. Telemedicine and asynchronous telemedicine for example are as effective as face-to-face care, also electronic consultations may reduce patient wait times for specialists' appointments, meetings, and decision-making [2].
A collaboration is launched during this research with the motivation of investigating the possible ways to contribute to the intelligent digital transformation that the Moroccan hospitals' known these recent years by creating and ameliorating the telemedicine capabilities among different specialists and services.
The success of any medical treatment is time management, especially for the oncology domain. The early cancer detection increases the chances of a successful diagnosis and might save the patient's life. Due to the COVID-19 pandemic, the idea of adopting virtual proceedings such as meetings becomes a need to solve and avoid the blockage of medical services and the severe delays that affect cancer patients [11]; Nevertheless, the problem that rises is the complexity of the Patient's Clinical Workflow.
The Patient's Clinical Workflow mainly is the interaction between actors in the hospitals over various tasks held in appropriate services, the medical information flows respecting the clinical workflow which must be represented very carefully with respect to detailed specification of the facility, any errors occurring the patient's clinical workflow will affect the data recorded in the Electronic Health Record (EHR), hence the whole Hospital Information System (HIS).
Due to the emphasis given to the subject, this paper aims to extend and discuss the previous study [4], where we modeled a Business Process Model that describes the patient's clinical workflow in the oncology service, as an example to analyze the availability and the efficiency of the digitization in Morocco. Nonetheless, building a base for future researchers and industries, to implement their solutions in the reality. The objective is to cover the rest of the services presented via BPMN and explain them by a consistent functional anal-

ysis, conserving the old findings.

II. State of the Art

Workflow in healthcare or clinical workflow speaks for the sequence of tasks performed (physically and mentally) by patients, professionals, and administrators within and between hospital environments [1]. Whether sequentially or simultaneously the workflow occurs at various levels [3]:

- **Inter-Organisational Workflow:** between services, for example, hospitalization service and pharmacy service.
- **Clinical-Level Workflow:** between people (patients, doctors, nurses, etc.) or between patients EHR and their clinical and healthcare process.
- **Intra-Visit Workflow:** the workflow occurred within a given service by following protocols and rules of the facility.
- **Cognitive Workflow:** the mental workflow that occurs during the decision-making or the orders' processes.

A. The Clinical Workflow's Conceptual Aspects

Usually, the clinical workflow is a process that occurs at various levels within the health facility, in information technology, the workflow and processes are often represented using business process modeling languages. The most popular among them is BPMN (Business Process Model and Notation) [9], and the UML Activity Diagram [10].
In a study concerning the healthcare processes and their representation using BPMN [8], the researchers are addressing and identifying the particular problems related to the roles and task assignment, they claim that BPMN fails to produce "nice and easily comprehensible results", they also precisely specify that the problems become apparent during process elicitation in a medical environment.
For this reason, they proposed an original approach by incorporating role information in process models using the color attribute of tasks as a complementary visualization to the usage of lanes. The clinical processes in a multidisciplinary hospital are inherently complex, which leads the researchers to introduce specific modeling requirements of the healthcare domain which will next be supported by BPMN to capture the processes:

- Many roles participate in one process.
- Several specialists work together on a shared task.
- A task can be alternatively performed by different roles.
- A task can optionally involve additional roles.

BPMN is known for its core modeling elements (Figure 1) Pools and lanes are used to structure the process diagram and separate respectively the organizational units and organizations.

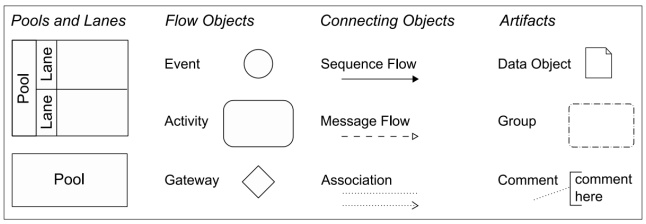

Figure. 1: Core BPMN graphical modeling elements [8]

Without going into the details of the approach, (Figure 2) shows how a clinical process is modeled using BPMN by describing in this example the preparation process for a difficult surgery, particularly this is done by capturing the requirements of many roles and shared tasks simultaneously, where the task is performed, by whom, and which role is affected to the performer [8].

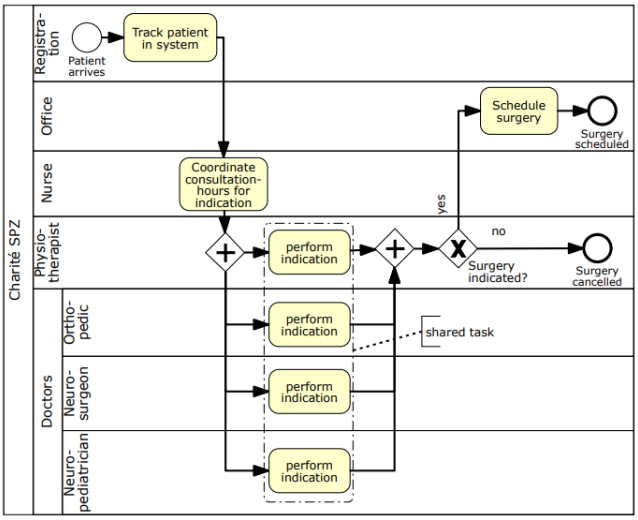

Figure. 2: A process of the preparation for a surgery [8]

Another example of the usage of BPMN to model clinical workflow is shown in [5], where the researchers provide a valid BPMN extension for clinical pathways (CPs) that can be applied by domain experts or even customized by model engineers. (Figure 3) demonstrates the evolved BPMN extension by presenting a simplified specific clinical practice guideline of a wisdom tooth treatment.

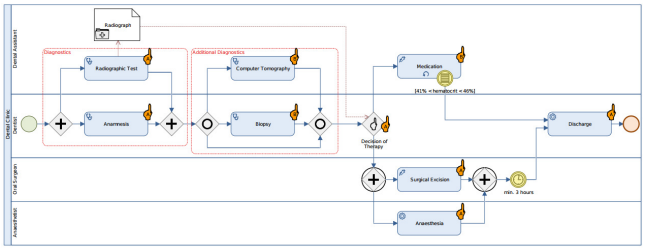

Figure. 3: A demonstration model of wisdom tooth treatment [5]

An additional study [13], in which researchers present a conceptual model of an oncology information system based on the users' requirements. They used a UML Activity Diagram to model the structural and behavioral workflow of the

system - more precisely the chemotherapy and radiotherapy clinical workflow (Figure 4) - based on data elements and functional requirements extracted, along with a cancer care workflows reported in [12].

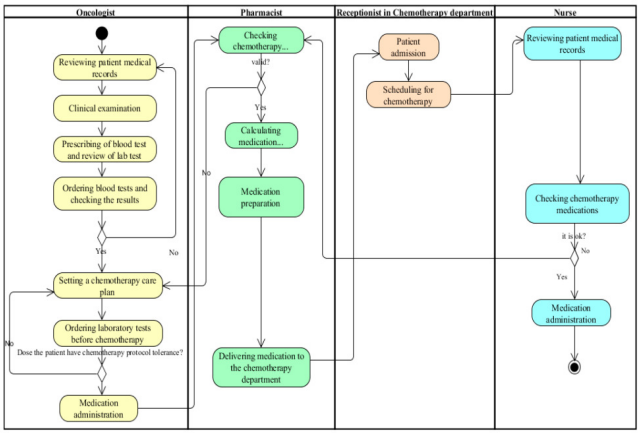

Figure. 4: Workflow diagram for the chemotherapy department [13]

Now that we reviewed the conceptual aspects of the patient's clinical workflow we have the technical guidelines to conceptualize its business process; However, there is still a need to match these guidelines with the Moroccan context and investigate their applicability.

B. Related Works to the Moroccan Context

In the context of the Moroccan hospital information system, several research studies have focused on the organization of the Patient Clinical Workflow, such as [6], a group of researchers analyzed the existing EHR at The National Institute of Oncology (NIO) at Rabat, the results were a reduction of the steps taken by the patient going back and forth between the institute's services, and improvement of the healthcare quality. They claim that they were able to reduce these twelve steps into two (Figure 5).
This proposal lacks precision because it is only focused on the medical assistance plan's patients (RAMED), while they assert that the proposal is global for the Moroccan context without paying attention to the plurality of services and the different types of patients' medical coverage within the institute. The hypothesis is that such a plurality will cause redundancy, which will affect severe delays, therefore rather than generalizing we end up multiplying the clinical workflow.

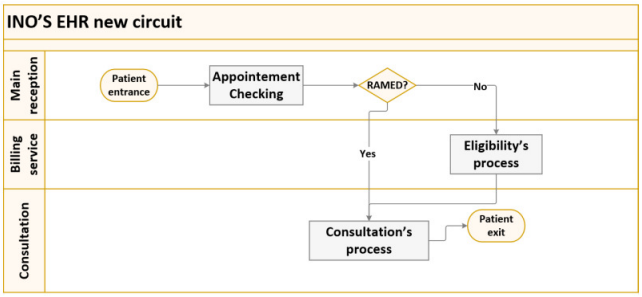

Figure. 5: NIO's EHR clinical workflow [6]

Another study [7] addressed a very important point which is the factors that influence delays throughout a patient's clinical pathway by documenting time intervals in cervical cancer care pathways. According to them the concept of delayed diagnosis has become an important issue; They categorized it into four components:

- Patient delay
- Healthcare provider's delay
- Referral delay
- System delay

Taking into account other influencing factors such as clinical, sociodemographic, and treatment they studied time intervals between 2013/2017 starting from symptoms onset to disease detection and beginning of treatment. They concluded that the integration of a model that standardizes the care pathways of the Moroccan health system is essential to unify cervical cancer care process in the country, this unification makes it possible to improve care pathways and reduces long waiting times.
The Patient Clinical Workflow is extremely advantageous as it sleeks the communication process and makes all information rapid, available, and interoperable, which makes a better connected HIS. The main benefit is allowing physicians to spend more time with the patient, where there is no need to chase clinical information (reports, paper records, files, and scans) it can also be shared within the hospital's services and among practitioners, not only at the local boundaries but also between any HIS around the world. In the light of these studies regarding the Moroccan context, the current research proposed a Patient Clinical Workflow representation of the oncology service of the RCO Tangier.

III. Methods and Materials

By investigating the various services, actors, and events within the Tangier's Regional Center of Oncology (RCO) workflow process, which is affiliated with the UHC of TTA. The current research proposes a generic business process model that can be implemented in oncology facilities regardless of the patient's type of medical coverage; To achieve that, we organized field research at the RCO, the field research has helped to propose several solutions that meet the:

- Oncology Patient Clinical Workflow specifications.
- Analysis of existing Clinical Workflow.
- Analysis of existing clinical workflow's situation.
- Alignment, genericity, and interoperability of any proposed business process with Hospital information systems' specifications.

By observing and conducting a qualitative study that includes noting all the characteristics of the various services provided by the RCO, the intention here was to include them effectively in the business process to clarify and reduce steps taken by the patients during their visits or their stay, and most importantly extracting the main medical information included in the workflow and necessary during other procedures done in the RCO, for example, the Multidisciplinary Team Meeting's discussions; These noted services include:

- Consultation service.
- Anatomical Pathology service.
- Biological Analysis service.
- Radiotherapy service.
- Chemotherapy service.
- Pharmacy service.
- Hospital Care service.

Using BPMN we represent the patient workflow, which contains various activities in oncology services performed in both administrative and operational ways (Figure 6), these activities are controlled by several events, connected using multiple associations, and communicated using messages or documents. As we are interested in elaborating a complete workflow, we studied the existing one in the RCO; In addition, we mapped various documents which are used in the other services and included them in the contribution.

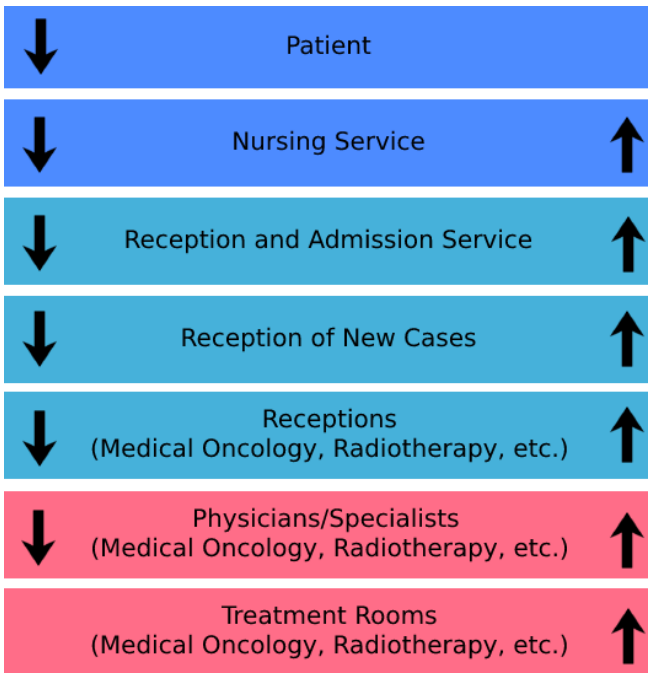

Figure. 6: The RCO's Oncology Clinical Workflow Main Components

By studying the existing situation at the RCO, we found that the patient's clinical workflow is divided into four BMPN models, two models for new patients and previously registered patients, the second models representing patients having the RAMED, who have medical coverage, and who do not. Following that logic, each service will have at least four business process models representing a simple clinical workflow with minor changes. The more complex the clinical workflow's representation gets, the more redundancy, and errors that occur in the OIS, which also affects the EHR. If the process is time-consuming, it will create a loop effect that never ends.
For this reason, our contribution is to unify the clinical workflow for each service of the oncology department using BPMN, then merge the verification process of patients' medical coverage to have one path avoiding business processes' redundancy.

IV. Results

This section exhibits a part of the proposed business process model and reveals its relationship with some proceedings in the oncology facility. Each time a patient arrives at the RCO the Reception and Admission Service (RAS) checks if he already exists in the system or not to be oriented to the reception of new cases. the RAS is in charge of the management of medical analysis and anatomopathological examinations. (Figure 7) shows the Reception and Admission Service reception workflow.
The RAS is taking charge of the invoicing, payment, and check-out operations, taking care of medical coverage proceedings and centralizing the other services of the oncology facility. In the (Figure 8) the patient consults a physician, then takes an appointment for the next basic consultation. For medical oncology the situation is different, the patient comes from the RAS with admission for pre-chemotherapy consultation, the reception manager at this service checks the appointment.
After the consultation the patient is informed of the approval of chemotherapy (or the rejection) to be oriented to the RAS for the chemotherapy treatment admission and invoicing. The process is continuing until the patient completes all the chemotherapy treatments sessions. In each step, many documents are recorded in the hospital information system.
In order for the patient to have any radiotherapy session, he needs to complete a dosimetric scan, then he waits for his treatment day, in this part, the RAS keep the charge of the admission and payment again, the patient then fulfills the requirement he passes to the treatment continuously until he completes all the sessions. For the patient to have any radiotherapy session (Figure 9), he needs to complete a dosimetric scan, then he waits for his treatment day, in this part, the RAS keep the charge of the admission and payment again, the patient then fulfills the requirement he passes to the treatment continuously until he completes all the sessions.
On the other hand both Biology and Anatomopathology services as long as the patient is admissable, the agents scan the labels of its samples (biological samples of the cancer patient) and input the analyses on the external prescription, this is held by a specific Laboratory Information System (LIS) called Elabs, in Elabs the samples are introduced to some automates. Afterward, the results are captured, validated biologically, and registered in the HIS.
As a result, we managed to expand the model to cover all the services in the facility, concerning all possible connections, relations, messages, and interactions between the actors. (Figure 10) shows the full representation of the patient's clinical workflow, as we can notice, the model is far more complex when it's combined than separated, which makes analyzing hard but plausible for the specialists and IT functional consultants.

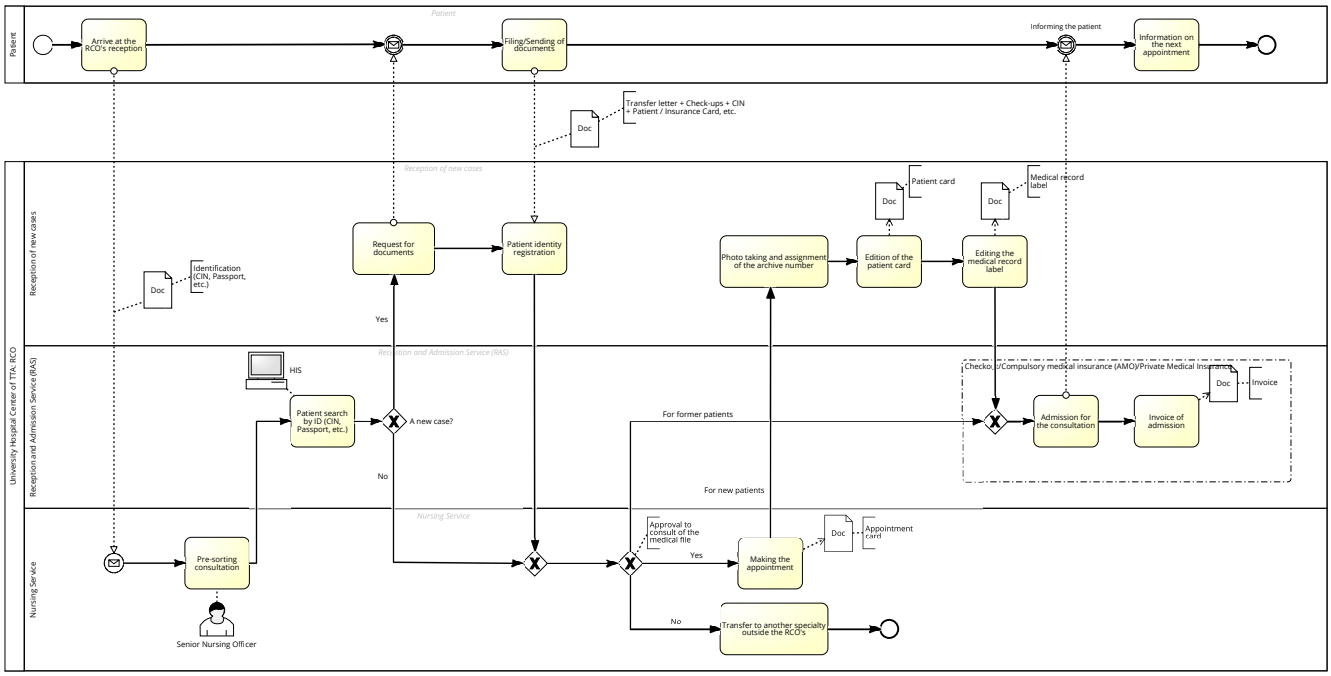

Figure. 7: Reception and Admission Service Patient's Clinical Workflow

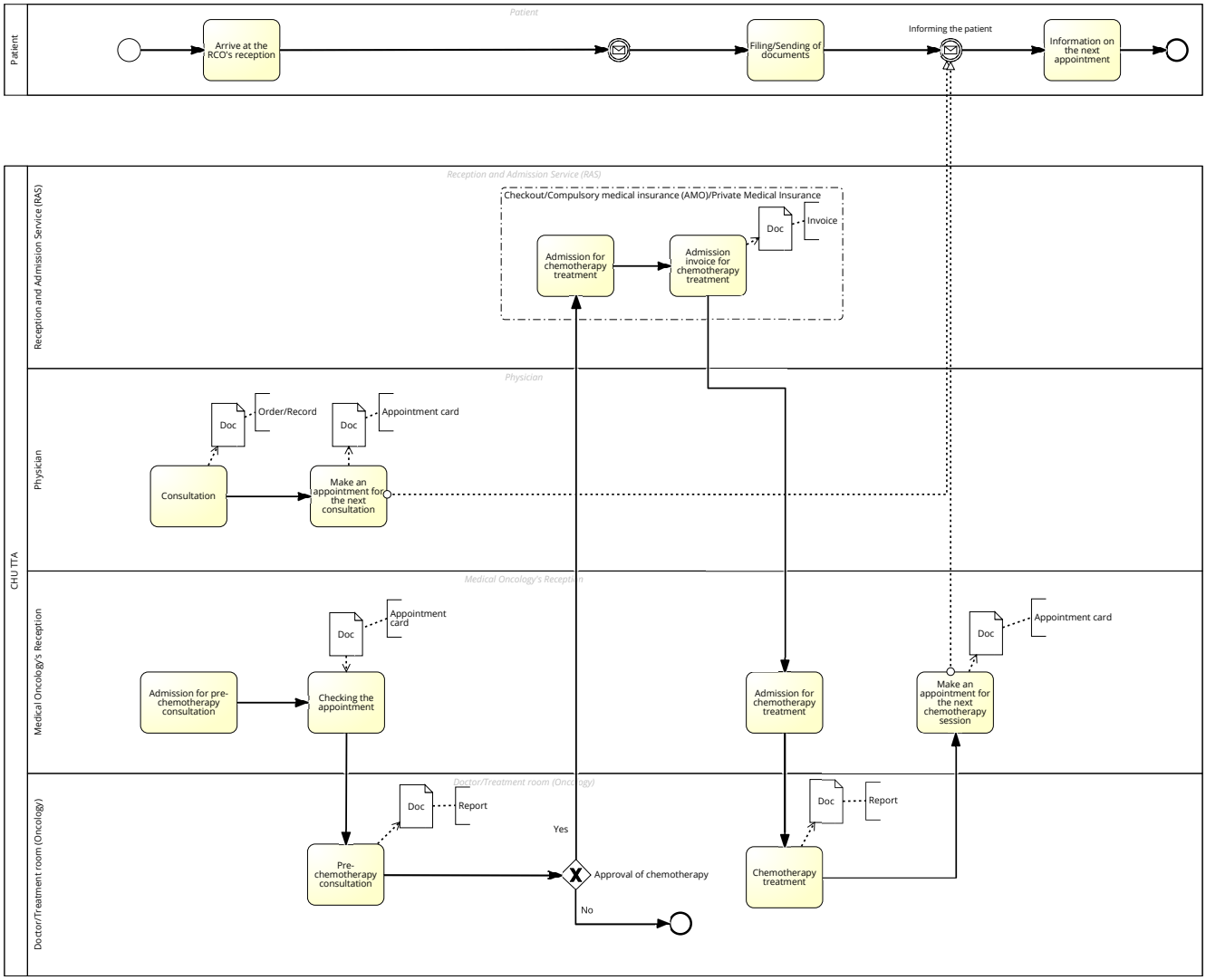

Figure. 8: Medical Oncology Service Patient's Clinical Workflow

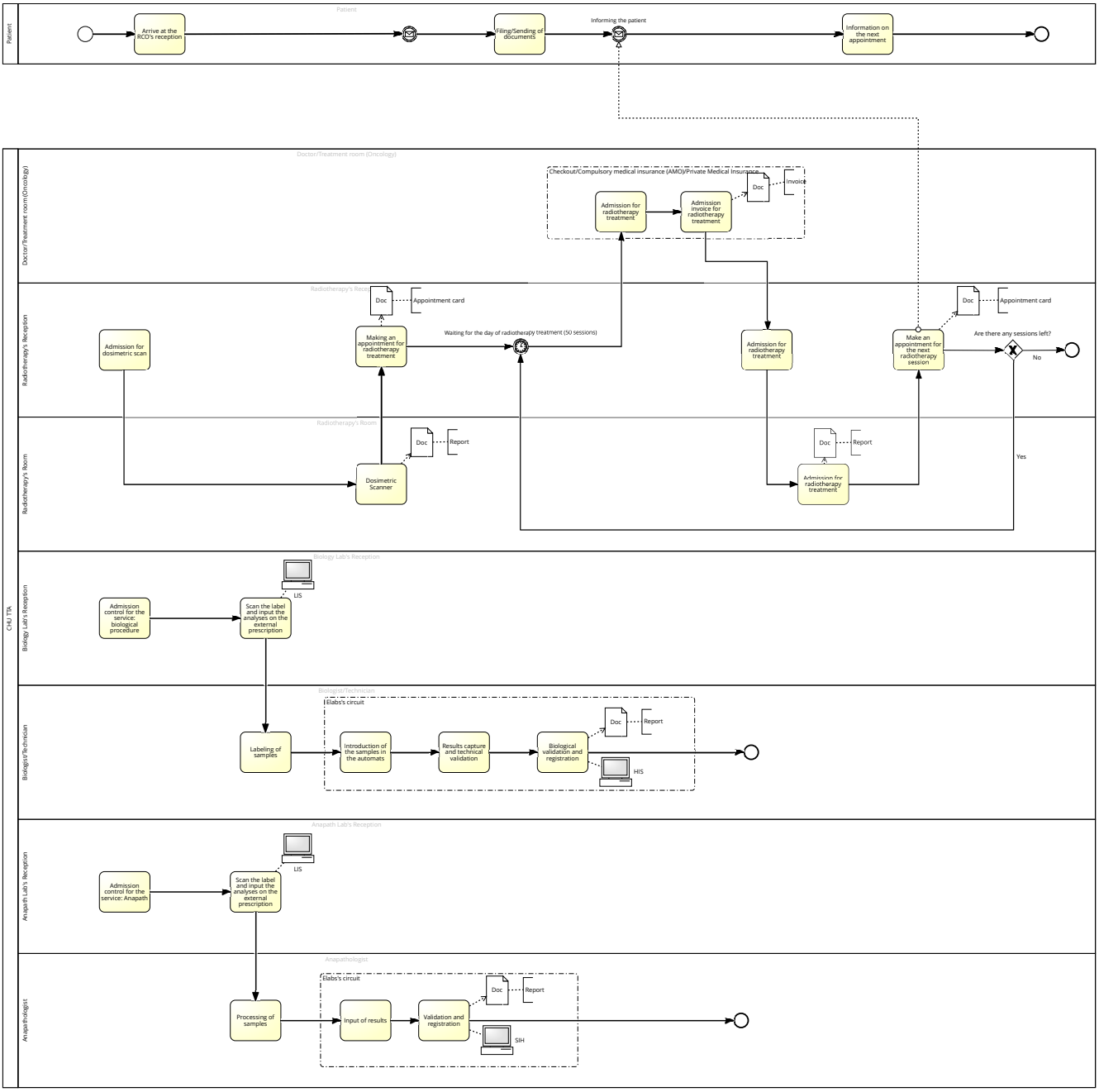

Figure. 9: Biology, Anatomopathology, and Radiotherapy Services Patient's Clinical Workflow

V. Discussion

This business process model covers all the components mentioned previously, as a result, this proposal mainly is remarking the development of a strategic vision to guide the implementation of well-conceptualized digital solutions in hospitals. Such a standardized description of the clinical workflow (healthcare process) will guarantee a logical assessment of data and technological infrastructures necessary for the development and deployment of information technology in Moroccan hospitals, especially the intelligent one. (Table 1) reviews the sequence of tasks performed by patients and professionals within various services in oncology department, which are represented in our business process model.

After visiting each service and specialist by the patient, multiple diagnoses, analyses, medications, and check-ups from all the mentioned services earlier are generated and included directly in the EHR, these pieces of information are founding the base of different proceeding in the RCO such as the Mul-

Table 1: Patient's Clinical Workflow analysis for the Sequence of Tasks Performed

Actor/Swimlane	**Activity/Task**
Patient	The patient is oriented by the RAS to be received by other services and either give him an appointment or a consultation, every service given to the patient is invoiced and must be recorded.
Nursing Service	Conducts a preliminary sorting of patients then orients them.
Reception and Admission Service	Orients new cases and checks patients admission, manages the cash register.
Reception of New Cases	Registers new patients, edition of patients' cards and EHR labels.
Physicians/Specialists (Medical Oncology, Radiotherapy, etc.)	Performs a physical or/and an artificial exam to assess the patients to determine the possible appropriate diagnosis for them.
Receptions (Medical Oncology, Radiotherapy, etc.)	Inform and refer patients during their visit to a service, or refer them to a related service if necessary.
Treatment Rooms (Medical Oncology, Radiotherapy, etc.)	Where patients are treated based on the service.

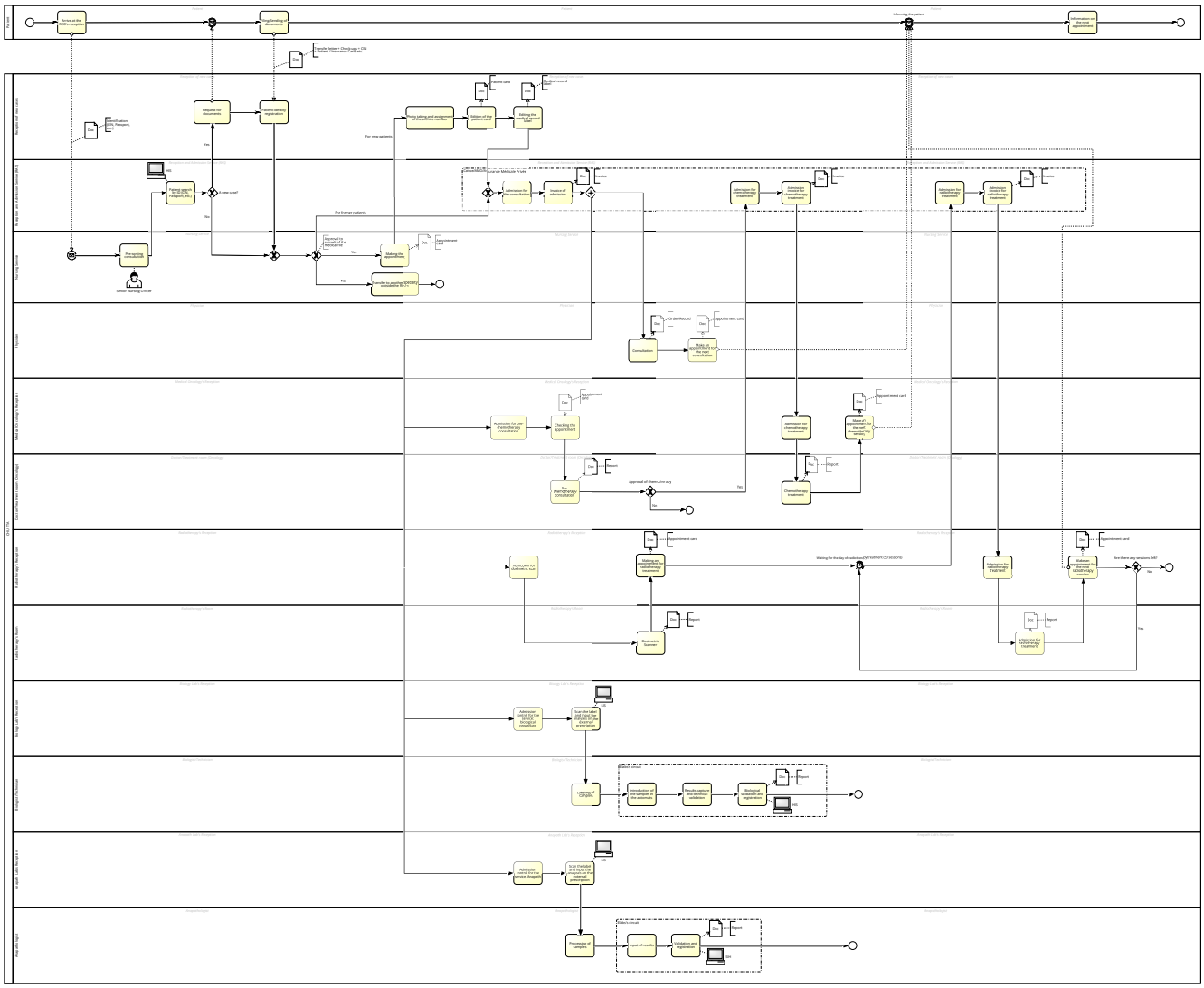

Figure. 10: Full Services Patient's Clinical Workflow

tidisciplinary Team Meetings' sheet and the Annual Patient's Reports.

Following the methodology described in this study for any use case can be beneficial. Not only to describe the current situation of a given organization from a functional IT perspective but also to analyze, study, and evaluate the level of satisfaction regarding the patient movements. Meanwhile, each step reduced could help the patients smoothly finish their operations from the few hours of their visit.

VI. Conclusion

Nowadays, with the blast of information technology usage, it becomes the backbone of healthcare and patient treatment in hospitals. In big complexes such as hospitals, adopting an information technology solution requires study and modeling, which gives us the Hospital Information System (HIS). within this HIS, information is circulating in a specific Patient's Clinical Pathway (according to the form of the organization) under the Electronic Health Records. Patients Information is recorded in the EHR and then could be extracted when needed.

However, regarding the literature review and the field research done at the Regional Center of Oncology Tangier, the Patient's Clinical Workflow must be represented with precision to gain a fluent information system with the minimum errors possible. This research implemented the Business Process Model and Notation to create a representation of the Patient's Clinical Workflow in oncology by reviewing previous practical experiences of national and international oncology facilities filling an organizational gap regarding the Patient's Clinical Workflow in general and unifying its representation over the national scale.

As for extending the current study, the researchers are working on ameliorating various telemedicine solutions based on detailed BPMN representations like the current study suggested; However, the continuity of this work shall be preserved where complex hospital services in Morocco still lake a clear clinical workflow analysis and standardization such as the surgery service.

Acknowledgments

A special thanks to Professors Abik Mounia (ENSIAS), Belhadaoui Hicham (ENSEM), El-Hfid Mohamed (FMPT) and Khazaz Rachid (ENOVA R&T) for providing support in

the construction of the models in this study, we thank the ENSIAS's Bio-MSCS Master's degree community for their moral support.

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