

Improving e-Health Services and System Requirements by Modelling the Health Environment

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Abstract— E-health is a rising research area in the public health, business and medical informatics sectors and refers to health and information services that are delivered or improved by using the Internet and other related information technologies. Various aspects of e-health are discussed in the literature; however, there is a research gap in the areas of system requirements engineering and e-health business goals. It is widely accepted that e-health business goals can play a pivotal role in capturing the details of e-health system requirements. Therefore, understanding e-health goals is important to obtain suitable e-health system requirements. This paper focuses on how business goal-driven requirements are elicited in e-health to help to fill this gap in the literature. This will aid e-health system developers in developing systems according to e-health business expectations. A case study on routine patient consultation visits in a health environment has been used to validate the approach and to ensure that an e-health system that successfully fulfils the needs of the e-health business is developed.

Index Terms—Health business process; system requirements elicitation, case study, modelling e-health process

I. INTRODUCTION

Through previous years, many e-health initiatives and innovations have been launched to achieve universal healthcare coverage and improve the quality of healthcare delivered to the public. These e-health innovations are directly connected to several social and environmental factors that rapidly change, such as population, the cost of living and lifestyles. Although e-health promises both quality improvement and higher efficiency, a large number of e-health projects have failed or are prone to fail [1]. As indicated in various works, many e-health systems become successful pilots and end users are pleased by the initial objectives that are reached in terms of product quality. However, most of the initiatives never develop into robust products that are used in daily practice [2, 3].

A core problem in most e-health projects is that they are highly technology driven, and the issue of eliminating ambiguity and closing the gap between stakeholders and software developers has never been addressed. This technological perspective has resulted in the failure of

some existing e-health projects [4]. It is difficult to understand and express the obligations and necessity behind e-health services in today's complex e-health environment. In most e-health innovations, system requirements engineering in terms of service and value proposition are not the starting point. According to Eysenbach [5], the term e-health characterises not only a technological or scientific development, but also a way of thinking. It involves an assurance of networked, worldwide thinking, and local, regional and international healthcare improvement, using information and communication technology (ICT). In this context, e-health must be understood as both a specific area of technology application and a particular paradigm of what is required from e-health to ensure e-health services are delivered to all stakeholders.

In e-health environments with numerous, scattered stakeholders, such as patients, individuals, professionals and organisations, e-health goals and values may vary and conflict with one another depending on stakeholders' perspectives of the environment in which these goals are being used and the services they aim to acquire. In this regard, requirements engineering is a solution to deploy e-health technological innovations, to facilitate the successful provision of healthcare services. According to Brooks [6], the hardest part of developing a software application is deciding precisely what to build. Therefore, the key function that software application developers perform for clients is the iterative extraction and refinement of the product requirements engineering phase [6]. Considering requirements engineering at an early phase of the software development lifecycle produces and fashions a broad range of product-related requirements as a priority to develop the product [7]. It is highly recommended to identify and match all system and stakeholder requirements of concern to requirements engineering.

It is widely accepted that business goals can play a pivotal role in capturing the details of e-system requirements engineering [8]. As a software system, e-health exists to fulfil the goals of different stakeholders, such as society, patients, professionals, health organisations and governments. These goals can significantly help the requirements engineering phase. As

cited in[9], software systems are erected to fulfil business goals. However, defining e-health business goals is not easy. First, e-health systems have multiple stakeholders from different backgrounds and with distinct goals. Second, some e-health goals are not explicitly articulated and must be actively elicited. Thirdly, the initial statements of some e-health goals are unreasonable in their strictness and need to inherit sub-goals.

The aim of this paper is to present the e-health business goal-driven requirements-elicitation approach in the context of developing a suitable e-health system. It also aims to answer the following questions:

- 1) Is modelling e-health business goals prior to deriving e-health system requirements a useful method in developing the system according to health practitioner expectations?
- 2) How e-health system requirements are derived from the health environment?

A case study based on routine patient consultation visits in the health environment has been used to validate the approach and to ensure the development of an e-health system that successfully fulfils the needs of the health business.

II. THE CONTEXT OF THE WORK

This paper presents an approach that models the health environment to develop a suitable e-health system that meets e-health business needs effectively. Therefore, it is important to describe the theoretical concepts of both e-health and requirements engineering prior to eliciting the e-health system requirements from the e-health business environment.

A. Understanding the e-Health Business Environment

Since the early 1990s, the e-health arena has faced rapid changes in terms of technology, environment and societal expectations. This has been considered a major issue that could negatively affect the performance of e-health systems. These rapid deviations in technology and expectations drive e-health innovation with technology rather than value creation. To compete in this environment, a strong and comprehensive understanding of the e-health environment is required. However, the literature indicates that the e-health environment and its goals in terms of requirements engineering have not been previously studied in depth. Software developers must have a clear understanding of the e-health environment and the goals expected from an e-health system to introduce an efficient e-health system that focuses on value creation, rather than technology. Moreover, this method will change the perspective of e-health research from *ex-post* to *ex-ante*, which is missed in most of today's e-health innovations [2, 4].

After a comprehensive literature review on e-health systems requirements [4, 10–12], it was determined that requirements engineering in the context of e-health business goals had not previously been studied in depth.

To this aim, a clear vision of the concept of goal-oriented requirements engineering and its approaches must be done, and this is the focus of the next section.

B. Requirements Engineering and Existing Work in Goal-oriented Requirements Engineering

Broadly speaking, requirements engineering refers to the branch of software engineering that concerns the process of discovering, documenting and maintaining the purpose of a software system by identifying stakeholders and their needs in a form that is amenable to analysis, communication and subsequent implementation [7]. Zave [13], provides one of the clearest and most cited explanations of requirements engineering, which highlights the importance of the main three axes of requirements engineering: real-world goals, functions and constraints. In the requirements engineering field, these axes motivate the development of a software system that presents the 'why' and the 'what' of a system. The definition provides the basis for analysing requirements, validating that these are the values stakeholders want, defining what software designers ought to build and verifying that they have done so properly upon delivery. Moreover, requirements engineering is a function that must be addressed from the contextual goals, as it answers why software is needed in addition to the functionalities the software must accomplish to achieve these goals and constrains restrictions to how they can be designed and implemented [14]. Therefore, software goals must be understood within the requirements engineering process of goal-oriented requirements engineering.

Although there is no one definition of the requirements engineering process, many works have agreed on four common tasks that are performed by requirements engineering processes [15–17]:

- Requirements elicitation
- Requirements negotiation
- Requirements specification
- Requirements validation.

Requirements elicitation is the main task of understanding the environment and the software situation. It involves recognising how the system aims to improve the situation and describing the developing system's needs. Requirements elicitation includes activities that enable the understanding of goals, objectives and motives for constructing a proposed software system. Elicitation also includes categorising the requirements that the resulting system must satisfy to achieve these goals.

C. Goal-oriented Approaches for Requirements Elicitation

Business goal modelling has been proposed in the course of requirements elicitation with the purpose of understanding the current organisational situation. In terms of requirements elicitation, many goal-oriented approaches have been proposed to describe current organisational behaviour by representing the goals of individuals, groups and organisations. Some of the most

common approaches are I*, EKD, goal-based workflow and GOMS model.

The I* approach [18–21] describes the work organisation in the sense of dependency relationships among actors. This approach admits that actors have the right to act within social constraints. This means that actors each have their own goals and beliefs that all connect to each other. The approach specifically embeds intentional components into the dependencies between actors, where they all aim to achieve goals, accomplish tasks, produce resources and satisfy soft-goals (non-functional requirements).

In the EKD approach [22–25], a business enterprise is defined as a network of connected business processes that cooperatively realise business goals. To accomplish this aim, the approach uses a network of goals to extract the causal structure of an enterprise in terms of the goals–means relationship, from the intentional objectives that control and administer the system operation to the real physical enterprise processes and activities available for attaining those objectives.

The goal-based workflow approach [26] presents the organisation as a set of goals (G), actors (A) and resources (R). In this approach, goals are attained by the collaborative actions of actors using available resources. The focus in this approach is on people and goals, rather than procedures and activities. In the GOMS approach [27], a goal is seen as an external task and a state of a system that the stakeholders wish to achieve. Generally, a goal is achieved using a device that has the ability to change the system to the defined desired state. A task, known as an internal task, is defined as the activities required or believed to be required to achieve a goal using a particular device. It is an organised set of activities in which actions are completed in a sequence. An action is defined as a task that does not involve problem solving or control structure components.

Ullah and Lai [28] planned business goal modelling using a requirements engineering approach. The aim of the approach was to help information technology (IT) developers to improve their understanding of business goals and objectives and their expectations of the required IT system. They recommend four attributes of requirements elicitation in regards to understanding business goals: who (defines stakeholders or goal agents), where (describes the location of the goal to be used), when (outlines the timeframe by which stakeholders need the goal) and why (describes what needs to be included in the goal and the reasons stakeholders need the goal to be implemented).

However, these methodologies have several drawbacks. The first and main drawback of the above-mentioned approaches is that all demonstrate the relationship and alignment between IT and business in a completely business-driven way. Therefore, the understanding of an e-health business environment is important prior to developing a system for a health organisation. The second is that e-health goals and objectives are complex because they are the combination of sub-goals that require exploration before goals can be completely analysed. The

third is that, considering the dynamic environments that characterise e-health innovation and the direct association with the rapid expansion of ICTs, these approaches are not efficient because they are time consuming. The fourth is that developing a suitable IT system that meets e-health needs and requirements on time is only possible when the e-health environment is able to be developed.

III. THE PROPOSED METHODOLOGY

Over the last decade, e-health innovations have been applied to develop and organise new ways of providing efficient healthcare services and to improve the quality of healthcare delivered to people. As such, these innovations need to be created from the initial requirements and values of an e-health system by understanding the e-health business environment, goals and how healthcare services are designed, offered and utilised. However, the development of an e-health system that meets the needs of an e-health organisation effectively is always a challenging task. In addition to understanding system requirements, e-health business activities must also be considered before commencing the development phase of an e-health system. Therefore, e-health goal modelling is required before system implementation to ensure the provision of better e-health services.

The methodology used in this study aims to aid e-health system developers in understanding the e-health business environment and in driving the system requirements from the organisational goals. The proposed methodology involves a clear understanding of e-health business environments to extract business goals efficiently, to elicit e-health system requirements. The methodology is divided into two main phases, as illustrated in figure.1. Phase 1 is based on a well-accepted business/IT alignment approach proposed by Ullah and Lai [28] and is categorised into three main levels: health organisation, e-health business strategy and e-health business infrastructure. Level 1 (e-health organisation) demonstrates the decision level of an e-health business environment and details the objectives of the organisation, available resources, executives and aims. Level 2 (e-health business strategy) ensures a responsive health strategy and plan for the e-health business, and leads planning with involvement of major stakeholders and sectors. This level describes the strategy of the e-health business in the form of health goals, targets, vision and evaluation of the health strategy. Level 3 (e-health business infrastructure) is the operational level that forms the foundations for e-health services and information exchange across geographical and health sector boundaries. This includes the core services, physical infrastructure, processes and activities.

Phase 2 of the methodology describes the method of modelling e-health business goals in the context of e-health system requirements. This phase demonstrates how to obtain e-health system requirements from the business goals that were extracted in Phase 1 and is known as elicitation of e-health system requirements. Further, this phase is made up of four stages: extracting e-health business goals, modelling e-health business goals,

analysing e-health business goals and eliciting e-health system requirements.

A. *Modelling an e-Health Environment*

The first phase of the proposed methodology aims to enhance the ability of e-health system developers to drive the system requirements based on a clear understanding of the goals associated with the e-health business. An e-health environment consists of three levels: the decision level, managerial level and operational level, and all three must be modelled to achieve this aim. These levels represent the e-health organisation as a whole, the e-health business strategy and the e-health business infrastructure, respectively. As mentioned, the idea of e-health business environment modelling is based on the well-accepted business/IT alignment approach proposed by Ullah and Lai [28].

1) *E-health organisation*

The e-health organisation level, which describes the actors, roles, interactions and value activities, is vital for encouraging logical thinking about how viable services can be provided and managed. This level also helps to determine organisational roles and responsibilities, as shown in figure.1. Moreover, the ability of the organisation to deliver the proposed e-health services is discussed at this level.

The above methodology describes e-health organisation in the form of organisational objectives, resources, executives and aims. These four components are required to determine the e-health organisation's purpose and goals. The organisational objectives represent what the organisation aims to deliver by meeting general health objectives, and this context will help shape the vision of what can be achieved [28]. Aligning these objectives with the available resources is an important task that must be managed by the organisation. For example, an organisation that is just beginning e-health deployment may focus on a limited set of objectives based on the available resources. Attaining this level in an e-health organisation requires a clear description of actors and managing roles, represented as 'executives' in the methodology. Finally, the aim of the organisation must be considered to determine what the

organisation is willing to accomplish in terms of e-health services. This component is extremely significant for executives, to ensure timely intervention when there is divergence between actual outcomes and aims.

2) *E-health business strategy*

The e-health business strategy level refers to the direction and scope of an e-health business organisation over the long or short term, and benefits the organisation through achieving aims and meeting the expectations of stakeholders. E-health business strategy encompasses several components that collaborate to demonstrate the e-health organisation's plan. These components include direction, where the e-health organisation is working towards long-term goals; scope, which determines the competitive environment and the activities involved; and advantage (performance), which describes how the e-health organisation will obtain better services that meet stakeholder expectations [28]. E-health business strategy also discusses the organisational resources and environment, as well as the organisational stakeholders.

This methodology expresses e-health business strategy in terms of e-health business goals, vision, evaluation and targets. E-health business strategy identifies indicative goals and targets for the advancement of e-health adaption across consumers, care providers, healthcare managers and vendors over a long-term plan. These targets and goals need to be identified clearly to determine why the organisation process exists and how the organisation's mission statement can be fulfilled. An e-health organisation's vision emerges from rationalising why advantage is needed and how the organisation's resources will be used to respond to the priority goals and challenges. It outlines the organisation's direction in terms of healthcare and how the available resources will help it to get there. Finally, the evaluation level is extremely significant in demonstrating how the success of the e-health organisation will be measured. A well-structured evaluation method determines overall organisational performance (for example, does the organisation provide better healthcare services that meet the organisation's vision and the stakeholders' expectations).

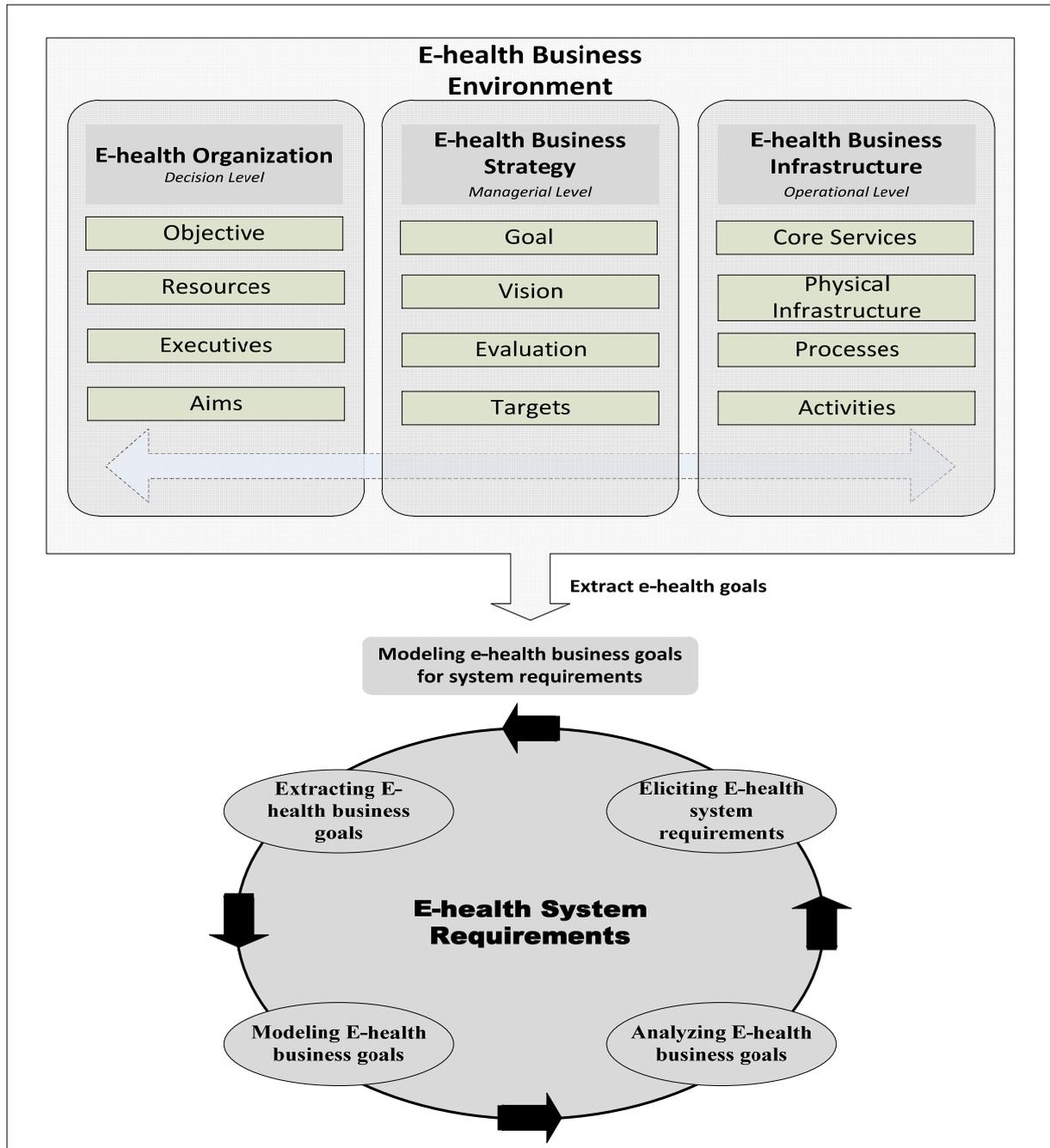


Figure.1: Methodology framework

3) *E-health business infrastructure*

The term ‘e-health information system infrastructure’ refers to healthcare-related technology, where ‘infrastructure’ is the physical technology hardware employed to interconnect information systems or a computer and its users. In the context of e-health, infrastructure includes transmission media (that is, telephone lines, cable television lines, patient data, information flow within the e-health system and other devices that organise communication paths) and the software used to receive, send and administer broadcasted signals. Moreover, e-health system infrastructure refers to

interrelating technology hardware and software and does not refer to interrelated information systems or computers and other devices. However, to some e-health system users, infrastructure is viewed as everything that supports flow and dispensation of information. It is widely accepted that many health-related services in developed countries do not view broad e-health infrastructures and information systems as essential to the future provision of secure, well-organised, high quality and improved healthcare.

After defining and developing the e-health business strategy, it is important to model e-health business infrastructure to define and link the basic elements that support e-health business goals and objectives[28]. This

level ensures that proposed e-health services and their purpose are discussed, and also ensures availability of required physical components in each single process in relation to the health information flows that currently exist or are being implemented within the same health sector. This level also examines ICT capabilities required to deliver the proposed e-health services to consumers and the extent to which these capabilities exist in the current health application and products. These constituents demonstrate the activity vision of the organisation, which fulfils the organisation's mission statement.

The e-health business infrastructure level in the above methodology is expressed using four sub-models: core services, physical infrastructure, processes and activities[28]. The first sub-model, core services, demonstrates the importance of the organisation's proposed services, including as regards the actors involved in these services and their beneficiaries. It also discusses the health and technical challenges that these services will attempt to address and resolve. To this end, it is important to determine the physical infrastructure and processes involved in each one of these services. The physical infrastructure and process sub-models indicate how advanced the e-health business organisation is in adopting ICT and providing services. Further, these sub-models examine the ability of the existing infrastructure components to scale up to support broader health sector use. Finally, it is important to identify the activities required to deliver the outputs of a particular action in the e-health business organisation. Defining e-health organisational activities will enable the determination of resourcing and funding requirements.

B. E-health business goal modelling and elicitation of system requirements

After defining and developing the e-health business environment, including the three main levels of e-health organisation, e-health business strategy and e-health business infrastructure, it is essential to define and link the basic elements that support e-health system goals and objectives. These elements are comprised of the main activities, processes, physical components and people of an e-health service that meet the e-health system objectives. Modelling the e-health system environment is a major step towards eliciting e-health system requirements from e-health goals and objectives. It demonstrates how e-health goals can be achieved by using areal environment scenario. At this stage, the interior relationships between core services, tasks and people involved in reaching system goals are described, which simplifies the task of eliciting system requirements.

During this process, Business Process Modelling Notation (BPMN) [29] is used to model the process of an e-health scenario. BPMN was developed by the business process management initiative group and is widely

recognised by business analysts and software developers. For software developers, BPMN simplifies the mission of understanding business activity flow and process through simple diagrams that are constructed from a limited set of standard notations. It is considered a standard modelling language that bridges the gap between the business model and development process.

A routine patient consultation visit to a healthcare centre has been used as a case study to model the e-health system environment. As the Australian healthcare system is considered one of the best in the world, the case study presented here is based on the Australian e-health record project (eHealth). This project aims to improve the sharing of clinical information between healthcare providers to deliver a more comprehensive and efficient e-health system. The case study was taken from the clinical scenarios available for healthcare professionals in the eHealth learning centre [30].

The routine patient consultation visit process is implemented using BPMN, as shown in figure.2. The case study's primary goal is to demonstrate the main activities that occur during a normal patient consultation at a health organisation and how e-health can be implemented to achieve organisational goals and objectives. The patient consultation process has been divided into four different phases: registration and doctor allocation, consultation, further examination and discharge. In the first phase, the healthcare provider (HCP) system retrieves the patient's data if the patient is already registered in the system or registers the patient as a new patient. It then allocates a doctor based on availability. In the second phase, the doctor undertakes the clinical examination with complete access to the patient's medical records, including his or her medical history, laboratory results, prescriptions and referrals. This ensures the doctor has a complete understanding of the patient's condition. In the third phase, patient referrals are given where further examination is required. This includes referrals to other healthcare professionals or departments, such as x-ray or blood collection clinics, and to medication departments for necessary medication after validating patient information, such as allergies. In the fourth phase, the administrator discharges the patient after organising a follow up visit if required and finalising the payment method. The case study shows how the e-health system will improve access to healthcare information and the ability of healthcare professionals to share information. Moreover, it illustrates how clinical practices may be enhanced once the e-health system is widely adopted and integrated with other existing healthcare systems.

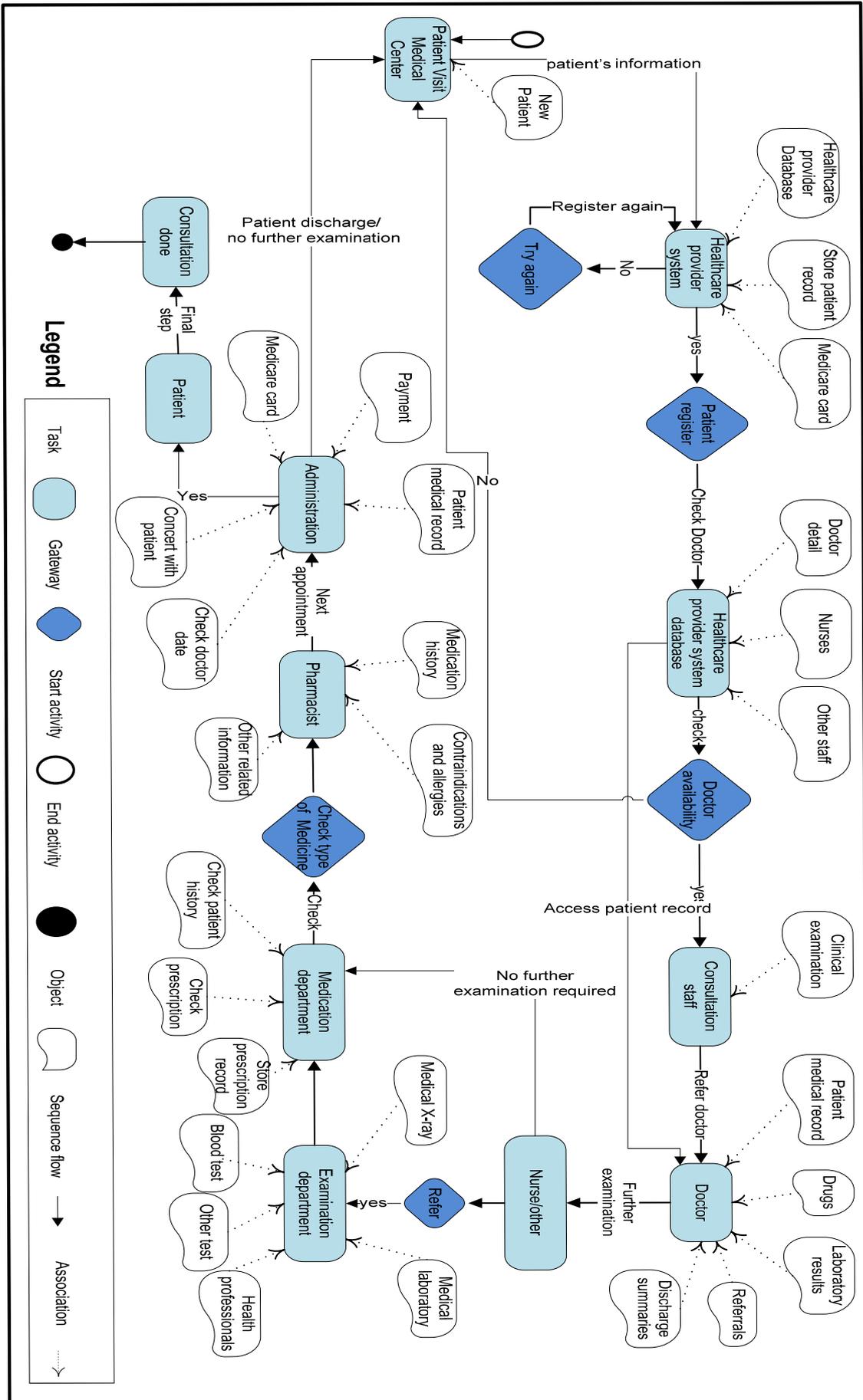


Figure 2: Routine patient consultation visit process

1) Analysis of the e-health system environment

Distractions from the system and conflicts between different components are the main explanations for rapid change in the e-health system environment. This is because the e-health environment consists of various technical and human components that clearly lead to rapid change in goals and processes. E-health systems include software, devices and ICTs, as well as many stakeholders with different technical skills and capabilities. In terms of e-health system environment analysis, this variety of components and stakeholders makes e-health system activity more complex and the goals become changeable. Consequently, the method of analysis must be flexible enough to ensure that rapid changes in e-health processes and goals can be managed.

Goal modelling is one of the most accurate methods of eliciting system requirements. It shows how different requirements can be implemented through each process to achieve the proposed goals. As indicated in many works [31–33], business goals can play a critical role in sustaining requirements engineering processes, including requirements elicitation, requirements negotiation, requirements specification and requirements validation. Moreover, a single business goal can carry more than one sub-goal that needs to be explored in regards to complete implementation. In the case presented here, e-health business goals express the e-health organisational goals and objectives that must be met. The proposed methodology uses goal and task concepts to model the e-health processes and to extract goals from it, as well as to analyse these goals towards eliciting system requirements. The methodology makes use of the goal tree concept to analyse the e-health system environment based on the anticipated scenario. The goal tree is a graphical representation of the reduction of main goals and sub-goals and is one of the most commonly used methods for representing goal models before eliciting and identifying system requirements[16]. The goal tree diagram for the anticipated e-health scenario is shown in figure.3, where rectangles are used to represent business goals and circles to indicate tasks that need to be performed in relation to the e-health goal. The main activities in analysing the e-health system environment, according to the undertaken scenario, are refinement and abstraction of the interior processes to accomplish the proposed health service. The goal tree diagram shows the manner in which each one of these processes is performed and why this is so. This will clearly show the main system requirement, which could be a human or technical requirement.

After the e-health process goal tree has been finalised, the goals are analysed to obtain valid e-health system requirements that answer the following questions:

- Who are the system's beneficiaries (that is, the stakeholders)?
- What is the need for this system?

- What other technical and human components should be included in the system?
- When and where is the system needed?

At this stage, IT analysts examine the goal and then label the leaf elements of the goal according to the nature of the goal and its corresponding tasks. If the IT analyst believes a particular goal or task cannot be automated, he or she marks it with a cross. After the goal analysis process has been completed, the goals and tasks that were marked with a cross are removed from the goal tree diagram. The goal tree diagram is then converted into a Unified Modelling Language (UML) state chart that presents a true picture of the system requirements elicitation. Figure.4 shows the goal analysis of the e-health scenario goal tree for the case study. It highlights the set of goals that must be implemented manually, such as clinical examination and blood tests. The remaining goals have been converted into a UML state diagram (see Figure.5) to present the exact vision of the system requirements, as detailed in the next section.

2) E-health system requirements

Developing an e-health system that is in accordance with e-health business demands is always a challenging task because of a lack of system requirements–elicitation techniques and a lack of business knowledge among e-health system developers. This negatively affects the performance of an e-health system. Therefore, it is important that requirements elicitation is done prior to the developmental phase of an e-health system. After the case study's goal tree has been finalised, the UML state charts are generated from the tree. Figure.5 demonstrates how an e-health system developer generates the e-health system requirements using a UML state chart. A total of seven actors are involved in generating the state chart: the patient, regular HCP system, medical staff, other health professional/examination department, community pharmacist, administration and medical record. The patient is someone who visits the medical centre for a normal consultation. The regular HCP system represents the medical centre administration system and is responsible for accessing patient files or registering new patients. Medical staff includes doctors and nurses who examine the patient, and other health professional/examination departments are other professionals who may need to check the patient for a second opinion or any other examination departments that provide further examination. The community pharmacist assists patients with medication and the administration is the actor responsible for discharging the patient after organising the next appointment and payment. The medical record contains the complete medical record of the patient and can be accessed by the doctor and other medical departments.

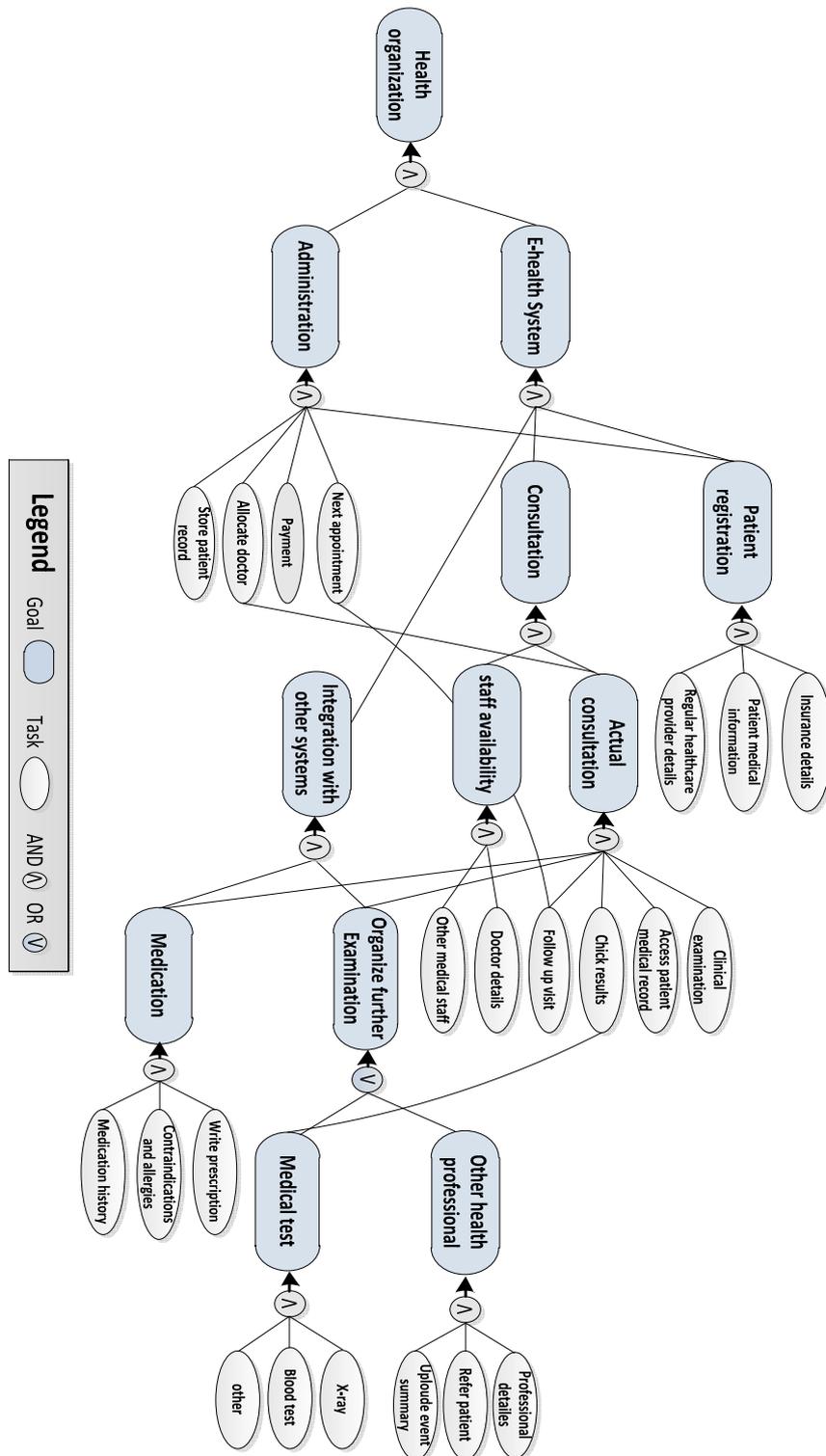


Figure 3: Goal tree for the routine patient consultation visit process

The UML state chart allows the system analyst to modify any requirement packages at any stage of the state chart to eliminate ambiguity. System analysts collect the e-health system task state charts into one package and send this to the developers for completion. E-health system developers first check the package to see whether it contains any goals or tasks that have been marked with a cross or a circle and, if so, the developer sends the

package back to the system analyst for further modification. In cases in which there is no error, the state chart package will be implemented. At this stage, the state chart diagram clearly depicts the e-health business goals, the required actions and the way in which they can be carried out. This positively influences the development of a successful e-health system.

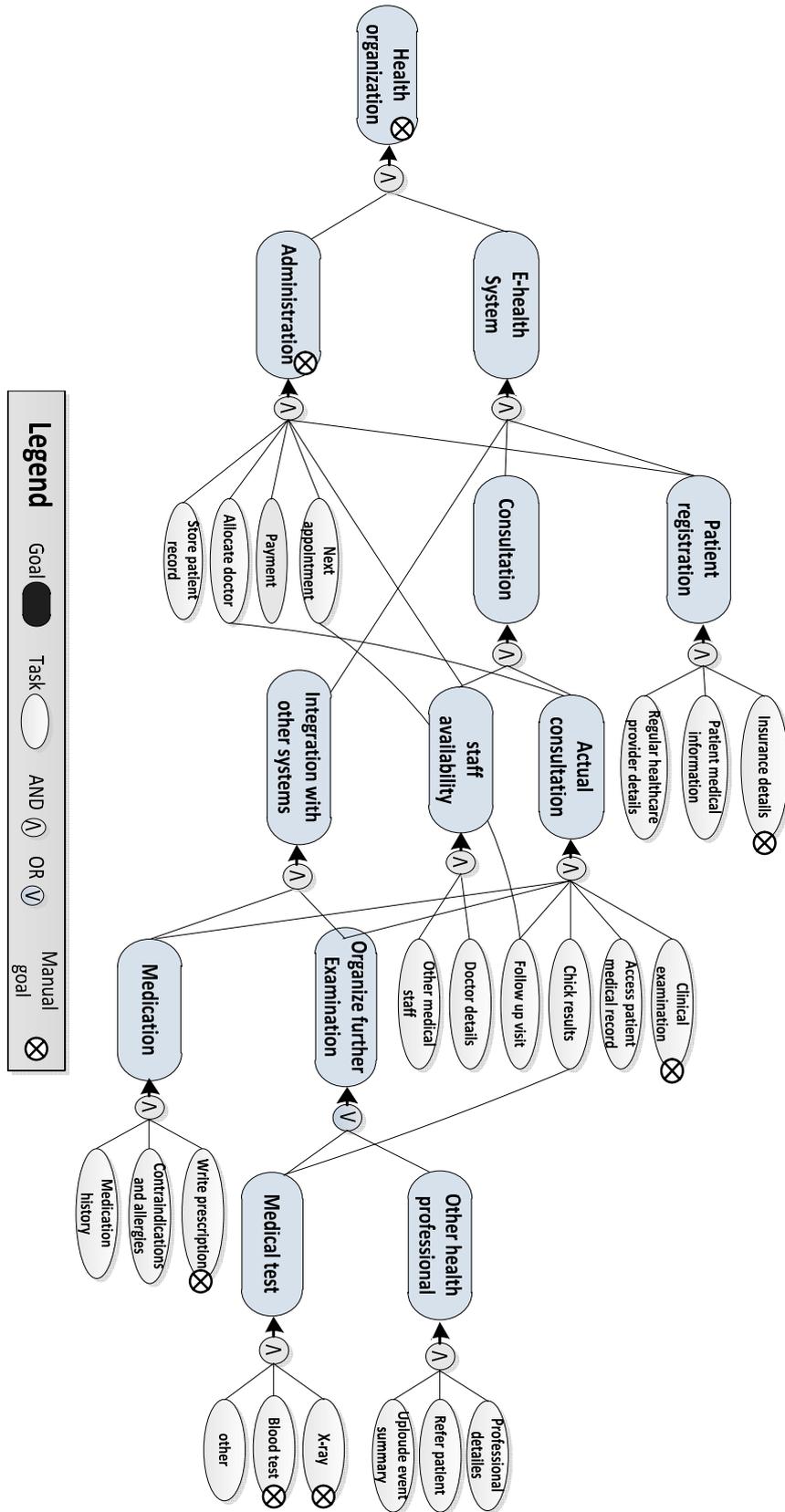


Figure 4: Analysis of the routine patient consultation visit process

The methodology has been validated successfully with real e-health business processes, and three major implications can be derived for e-health researchers, e-health business analysts and e-health information systems analysts. First, providing technological services on time to e-health business administration is always difficult and, while researchers have been working on this issue for many years, e-health business managers still consider this issue unsolved and rank it at the top of all e-health issues. This paper introduces a new approach in regards to providing on time technological services, which has been successfully validated with a medical company business process.

Second, modelling e-health business processes is always a challenging task. The BPMN method defines a

simple way of modelling e-health business processes that is easy for e-health analysts and other e-health business stakeholders to understand. Third, understanding and deriving e-health business information systems requirements is difficult because of e-health process complexity, as one health process can carry more than one health goal and every goal is associated with others. This proposed methodology defines how the e-health process can be considered before the e-health information system development phase commences. This enables e-health processes and information system requirements specifications to be modelled more accurately.

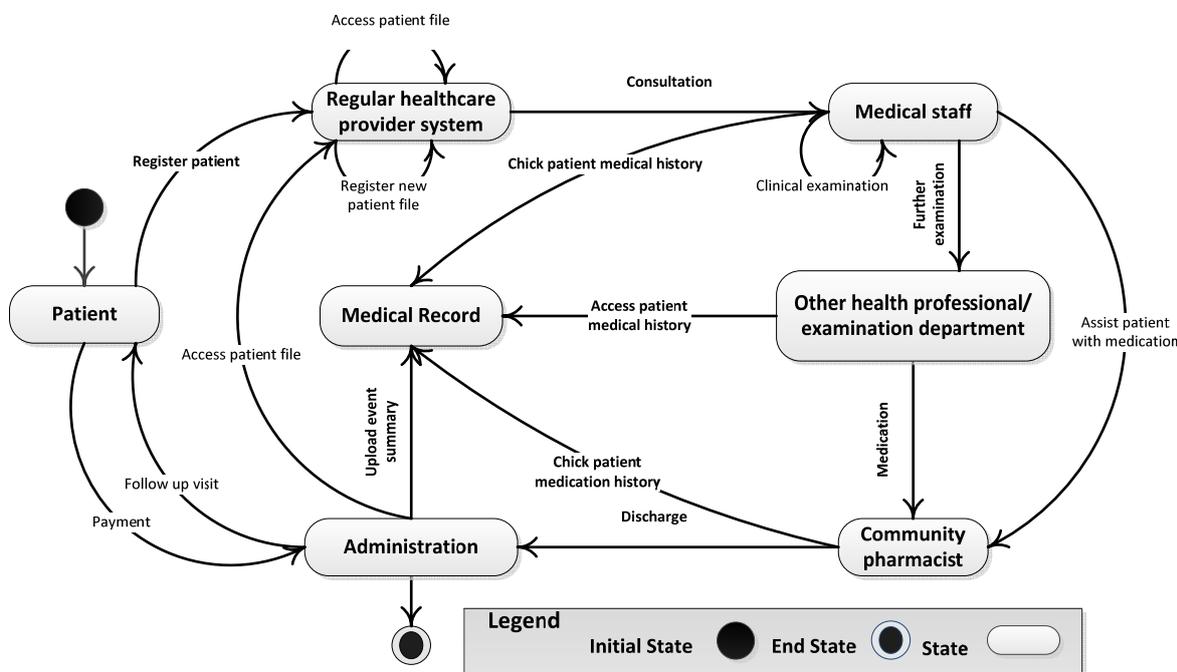


Figure.5: How to extract system requirements from a routine patient consultation visit process

IV. CONCLUSION

IT is part of most people’s daily life. Whether it is buying groceries via a card instead of cash, sending an email rather than posting a letter, or paying bills online instead of by cheque, the use of technology increases the quality and security of the service involved and saves people time and money. E-health is the combined use of electronic communication and IT in the health sector.

This paper presented an approach to modelling and analysing e-health organisation and e-health business goals to elicit e-health system requirements to develop a suitable e-health system. This approach was structured in two stages: Stage 1 explains how to model and analyse the e-health business environment and includes e-health organisation, strategy and infrastructure, and Stage 2

explains how to model and analyse e-health business goals in terms of the IT environment and includes modelling e-health business goals using BPMN, analysing and connecting e-health business goals using the goal tree diagram and extracting system requirements from e-health business goals using UML state charts. This approach was effectively implemented and tested against a real e-health business goal, bringing the following benefits to e-health organisations: helping e-health system developers to identify e-health business goals and associated sub-goals, and allowing e-health system developers to implement the system according to the e-health business organisation’s expectations.

Moreover, in relation to the requirements engineering concept in the e-health domain, it is widely accepted that health processes and the associated goals can play a

pivotal role in capturing the details of health and non-functional system requirements engineering [34-36]. This paper derived system non-functional requirements from health process.

However, the presented approach has several limitations. First, it is limited by the validation of only one e-health business goal, so there is a need to authenticate it with different e-health business goals that address different health problems. This is because e-health business goals vary depending on context [28]. Second, the approach does not explain how to extract all e-health business goals prior to implementing the methodology. Third, the approach manually models and analyses e-health business goals; however, goals change rapidly, the management of which requires automatic modelling and analysis of goals.

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