Abstract

This study aims to redesign and measure patient satisfaction and treatment of the patient flow process. Based on ontology, it will redesign the core patient flow processes with the simultaneous introduction of a patient-oriented model that will conceptualise and implement this ontological framework.

A gap regarding scientific, patient-oriented, measurable frameworks has been discovered and demonstrates the need for a new healthcare management framework. As the need for this new framework is identified, this study aims at fulfilling the following objectives:

- A novel redesign of core transactions of the patient flow process, based on ontology, and its supporting patient-oriented information system, from being healthcare oriented to being patient oriented.
- Implement this study's conceptualisation (patient-oriented flow) in a novel beyond any doubt, way through the function of the supporting information system as well as its measures used for the ontological process redesign.
- Improve efficiency in the healthcare system through competent management of institutional resources by providing a fertile framework for strategic cooperation among patients and healthcare providers.
- Assist in the development and maintenance of measurable activity-based driven results that improve patient quality value added services, turning everyday healthcare acts into healthcare facts relevant to this study's concept.

Concluding, scientific contributions of this study include the discovery and redesign of the contemporary both conceptual and structural gaps in the patient flow process and the introduction of a measurable scientific, not practical, redesign through the enterprise ontology methodology. Finally, the implementation of a novel patient-oriented framework (OS), based on universal characteristics, that results to effective GP appointment, proper diagnosis and referral, economically traceable and structurally measurable, both qualitative and quantitative, hospital inflow-outflow as well as patient awareness and patient relations management.

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In the last six years this study has been in the centre of my life. I consider this study as a collective endeavour due to the support I received from my business associates at CPG Consulting and of the American College of Thessaloniki, valuable resources.

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Declaration

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National Patient Flow Framework: An Ontological Patient-oriented Redesign

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Key to Abbreviations Used

ABU	Activity-based Unit
AHCPR	Agency for Healthcare Policy and Research
AI	Artificial Intelligence
ANSI	American National Standards Institute
ASA	Administration Simplification Act
ASC	Accredited Standards Committee
BB	Black Box Model
BFO	Basic Formal Ontology
BPI	Business Process Improvement
BPR	Business Process Reengineering
CARF	Commission on Accreditation of Rehabilitation Facilities
CDA	Confirmatory Data Analysis
CDS	Clinical Decision Support
CFR	Combined Federal Register
CIM	Clinical Information Management
CIS	Clinical Information System
CMS	Centres for Medicare & Medicaid Services
CPG	Clinical Process Guidelines
CPI	Continuous Process Improvement
CPR	Computerized Patient Record
CRM	Consumer Relationship Management
DBMS	Database Management System
DEMO	Designing and Engineering methodology for Organisations

DFD	Data Flow Diagram
DISA	Data Interchange Standards Association
DSS	Decision Support System
EDI	Electronic Data Interchange
EDIFACT	Electronic Data Interchange for Administration, Commerce and Transport
EFQM	European Foundation for Quality Management
EMC	Electronic Medical Claim
EMR	Electronic Medical Record – synonymous with Electronic Patient Record (EPR), and Computerized Patient Record (CPR)
EPC	Event driven Process Chains
EPR	Electronic Patient Record
ERD	Entity Relationship Diagram
ERM	Entity Relationship Modelling
ERP	Enterprise Resource Planning
HCFA	Healthcare Finance Agency, responsible for oversight of the U.S. Medicare Programme
HCO	Healthcare Organisation
HEDIS	Health Plan Employer Data and Information Set (Measures managed care programme performance indicators)
HHS	US Department of Health and Human Services
HIPAA	Healthcare Insurance Portability and Accountability Act of 1996
HIS	Hospital Information System
HL7	Health Level Seven - Founded in 1987
HL7-RIM	Health Level 7, Reference Information Model
ITA	Information Technology Architecture

ISDM	Information Systems Development Methodology
ISO.	International Organisation for Standardization
ISO/TC215	International Organisation for Standards, Technical Committee 215 – Health Informatics
JCAHO	Joint Commission for the Accreditation of Healthcare Organisations
NCQA	National Committee for Quality Assurance
NCRR	Division for Clinical Research Resources
NHS	National Healthcare System
NIH	National Institutes of Health
OECD	Organisation for Economic Co-operation and Development
OLAP	On-line Analytical Processing
OLTP	On-line Transaction Processing
OOA	Object-oriented Analysis
ORD	Ontology Relationship Diagrams
ORM	Object Related Methodology
OS	Object System
OWL	Web Based Ontology Languages
PACS	Picture Archiving and Communication Systems
PEHS	Patient Evaluation of Hospital Services
POEM	Patient-oriented Evidence that Matters
POM	Patient-oriented Measurements
POMS	Patient-oriented Measurement System
PRM	Patient Relationship Management
RDF	Resource Description Framework

RFC	Request for Comment
RIM	Reference Information Model
SAD	Systems Analysis and Design
SAGE	Standards-Based Sharable Active Guideline Environment
SCHIP	State Children's Health Insurance Programme
SDLC	Systems Development Life Circle
SSADM	Structured Systems Analysis and Design Methodology
SSM	Soft System Methodology
TC	Technical Committee
TQM	Total Quality Management
UML	Unified Modelling Language
UMLS	Unified Medical Language System
US	Using System
USAM	Unified Service Action Model
X12.	Healthcare Claim Standards from ANSI-ASC
X12-XML	Healthcare Claim Using Extensible Markup Language
XML	Extensible Markup Language
WB	White Box
WHO	World Health Organisation

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Chapter 1 Introduction

1.1 Brief Introduction of the Study.

The last decade has been characterised by environmental changes of internal and external demands and accelerated technological advancement transforming organisational roles and theories. It has been a decade of Constant Improvement (CI) and learning programmes (Senge, 1990) towards quality of services. Total Quality Management (TQM) (EFQM, 1991), six sigma (Nonaka and Takeuchi, 1995), Continuous Process Improvement (CPI), Continuous Process Management (CPM), Self-managed teams, and Business Process Reengineering (BPR) and Performance Measuring Systems (PMS) are some of the processes that underline this trend (Hammer and Champy, 1993). All these processes express changes in the nature of work, lively competition and national and international improvement initiatives for measuring business quality performance. This study will research patient-oriented frameworks that will strategically integrate the external and internal healthcare environments focusing on accessible, effective and efficient patient flow.

Today’s corporations and institutions continue to re-engineer from a product-oriented approach to a consumer-oriented approach. Consumer Relationship Management (CRM) systems embrace such an effort as vibrant globalisation highlights the growing demand by healthcare businesses for both internal and external information for the assurance of consumer-focused performance measurements (Papagiannis, 2001).

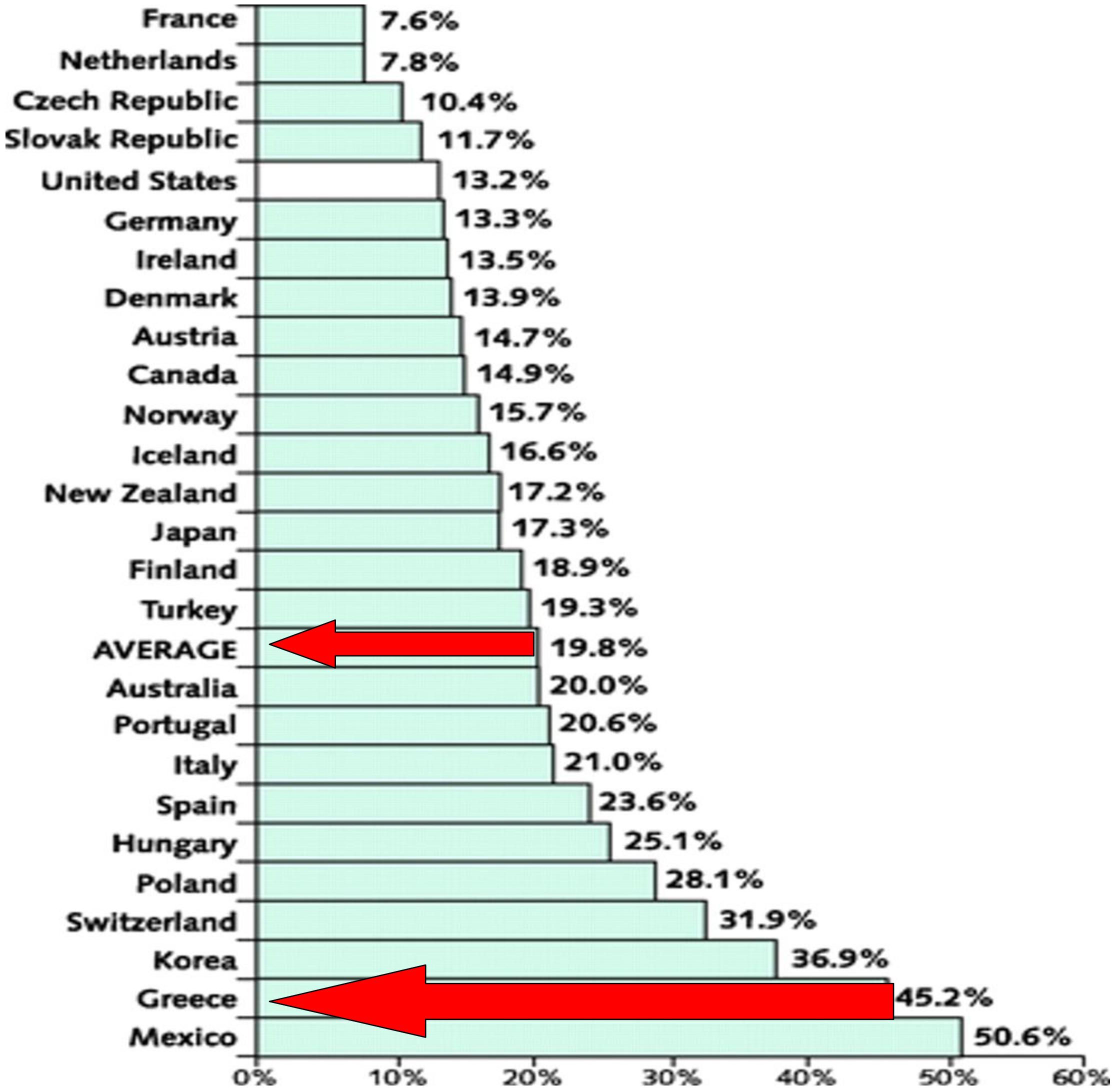
On the other hand the healthcare system in most countries is in a state of crisis. Escalating costs, in USA, have reached very high levels forcing patients to pay up to 13% of their income (Boschert, 2001). In 2005, national healthcare spending amounted to approximately $2.0 trillion or the 16% of the gross domestic product (GDP). By 2015, healthcare spending is expected to reach $4.0 trillion which will amount to 20% of the GDP (Centers for Medicare & Medicaid Services: Office of the Actuary, National Health Statistics Group).

Healthcare consumers are influencing the policy, strategy, operations and investment decisions of healthcare entities. The healthcare industry can expect a continuous need for quality measurements and reporting (Smith and Swinehart, 2001).

The CARF (Commission on Accreditation of Rehabilitation Facilities), the JCAHO (Joint Commission on Accreditation of Healthcare Organisations) On the other hand other accredited services are working towards patient satisfaction in organisations in Canada, Ireland, Sweden, England, Austria, Australia, Italy, Scotland, Finland, and Denmark, Germany and the USA in order to assure patient quality service (Katzfey, 2004). Patient satisfaction information and measurements should be critical parameters for healthcare providers in an effort to apply them in institutional operations towards a patient-oriented strategic framework (Stavert et al., 2003).Research outcomes, even if they take care of all the above highly complex measurements, are subject to the procedures and methodologies used to collect, process and interpret results (Avraham, 1999). Thus international cohesive quality standards are beyond the aim of this study.

1.2 Motivation

This study will focus, however, on Greek patients and their flow through the healthcare system as they are paying the most out of their pockets according to the OECD countries exhibited in the figure 1.1. Paradoxically Greek patients are by law fully subsidized for their healthcare costs, as they are covered by their public healthcare insurance funds. Primary as well as secondary research will try to provide sufficient evidence of the need for an alternative patient-oriented flow in the country that will provide patient satisfaction and treatment.



Source: Congressional Research Service based on OECD Health Data 2006 (October 2006).

Figure1.1: Percentage of Healthcare Costs Paid out of Pocket, 2004.

The study was conducted in hospitals in the area of Northern Greece in order to analyse and solve problems related to patient satisfaction and treatment levels. According to the figure 1.1, both levels are low, as patients are obliged to pay very high costs in order to receive treatment and satisfaction (Centers for Medicare & Medicaid Services: Office of the Actuary, National Health Statistics Group). Most of the contemporary studies focus on the redesign and optimisation of the patient flow without consideration of this study's conceptual framework. This study focuses on specific patient flow transactions and measures that should be encompassed within the patient flow framework that is designed. Contemporary healthcare at the national level would thus be designed around patient needs, as it obviously pays significant amounts of money, and not only healthcare resources. According to the aim of this study a patient could make an informed decision based on this patient-oriented framework.

The core transactions of the proposed patient flow process focus on optimal patient treatment quality results. The patient’s selection transactions should start from a hierarchical rating based on the healthcare organisation’s factual information, such as the satisfaction ratio of patient treatment as well as the availability of healthcare services and resources which will embrace the patient needs (Papagiannis and Danas, 2005). Thus, in addition to developing tacit and explicit knowledge through this information system, credible patient-oriented results ensure follow up of the patient flow as well as proactive healthcare practices. According to Steinke (Steinke et al., 2003) proactive acts in healthcare could develop patient satisfaction outcomes for the healthcare organisations to study in order to remain competitive.

The term elective patient is referenced in this study to describe patients who are in position to communicate with the healthcare environment (Wolstenholme, 1999). This study will focus on elective patients, in order to encompass patient’s perceptions of this study’s concept. In routine incidents where the elective patient could decide on the flow paths, there is usually neither a clear code of communication standards nor a series of transactions and processes in the patient flow that assure patient-oriented results and measurements of comprehensive patient satisfaction (Papagiannis et al., 2005). This study will focus on elective patients and the transactions they have to face during their flow through the system. Figure 1.2 exhibits an example of an elective patient’s satisfaction regarding the healing circle of the patient.

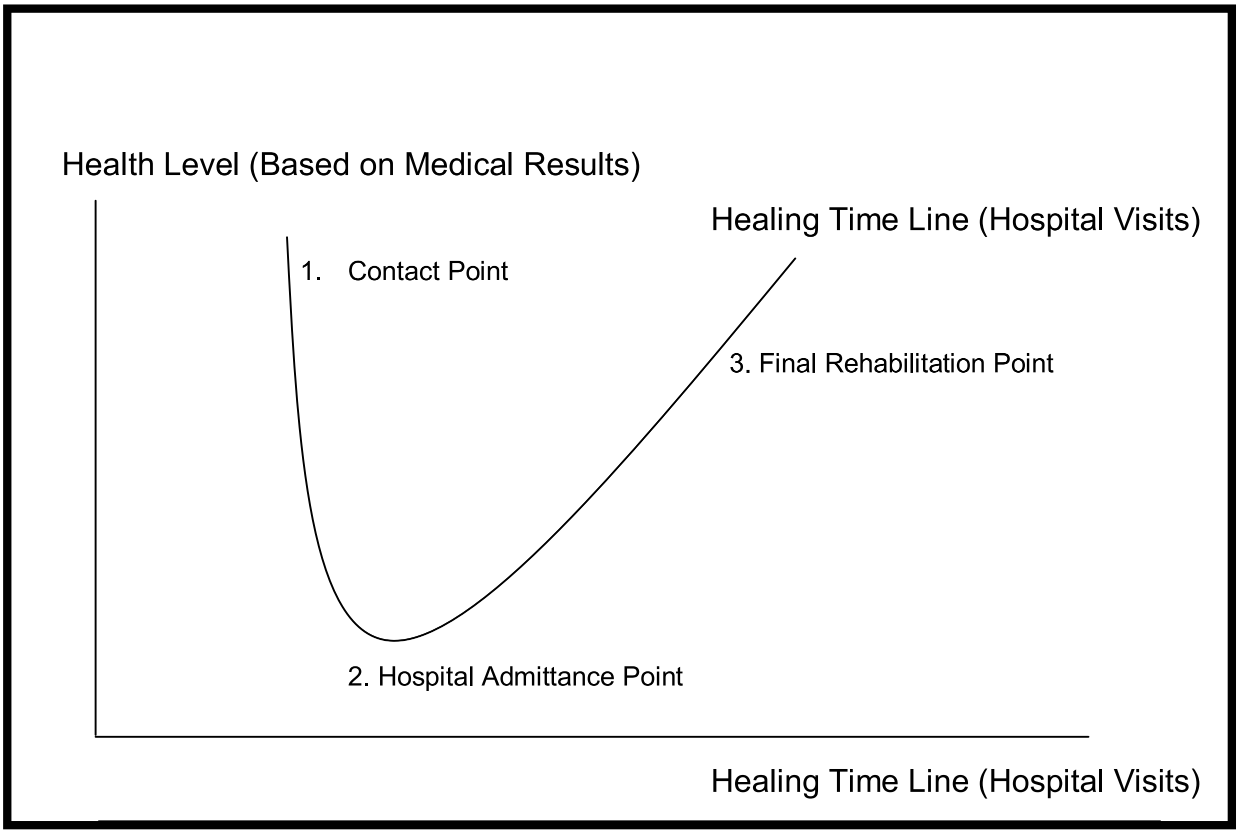


Figure1.2: Patient Healing Circle

In this figure, the patient contacts the national healthcare line to make an appointment. The healing time line is represented in this study from the patient flow and is the necessary time frame for the patient to recover from point two that is the patient's hospital admittance, until point three, which is the final rehabilitation point. At this point the patient's condition should be as it was before the initial communication point. That time period should be measured with several quality measures in order to implement this study's concept.

Tangible resources including facilities, equipment, financial resources, technology and organisational systems are less important in determining the success of healthcare organisations. Criteria based on intangible resources such as the right use of intellectual capital, efficient transaction services, and effective organisational knowledge based on excellence of information flow is quite important. In the same resource-based view, fair resource allocation and services based on hospital cost centres are rather important for such a strategy (Gruber, 1993)

Finally another major motivation of this ontological methodology includes the conviction that the world is in great need of transparent operations, a need which will be increasing if one imagines a future life in a cyber culture. So, a lack of harmony among philosophical, technocratic and bureaucratic thinking might produce errors and omissions in a future cyber culture.

1.3 Aim and Objectives

This study aims to redesign and measure patient satisfaction and treatment of the patient flow process. Based on ontology, it will redesign the core patient flow processes with the simultaneous introduction of a patient-oriented model that will conceptualise and implement this ontological framework. The redesigned healthcare model developed is based on integration fundamentally as an activity and then as a process, not a structure. Integrated patient flow process aims at the quantity and quality of healthcare cases and basic information exchange. It aims at fulfilling the objectives of the national healthcare system, if in existence, with regard to patient-centred care. There is great difficulty in establishing cohesive health measurements and standards, as the evaluation of quality is subject to clinical measures. Death or mortality rates, functional status measures, well being and healthcare costs are highly correlated with the patient’s profile and characteristics, such as age, behaviour, health status and demographics data (Eipstein, 1998).

On the other hand, the contemporary similar world consumer-oriented applications clearly state the definition of consumer satisfaction. According to Eipstein (1998), satisfaction is defined as a comprehensive measure that reflects the patient’s perceptions concerning all of the above outcomes and thus, it may provide the most inclusive measurements for the study’s theme.

It is a fact, according to a literature review of this study that any national healthcare system is aiming to satisfy its patients with effective proactive treatment with the best quality service accessible to everyone. The objectives of this study are to:

- Redesign core transactions of the patient flow process, based on ontology, and its supporting patient-oriented information system, from being healthcare oriented to being patient oriented.
- Create a patient-oriented framework based on a patient-oriented model.
- Implement this study's concepts through the supporting information system as well as its measures used for the ontological process redesign.
- Develop the necessary value-added patient transactions on a national level using spin-off measurable quality information.
- Improve efficiency in the healthcare system through competent management of institutional resources by providing a fertile framework for strategic cooperation among patients and healthcare providers.
- Develop and maintain measurable activity-based driven results that improve patient quality services, turning everyday healthcare acts into healthcare facts relevant to this study's concept.
- Gradually establish model trends that will serve as thresholds for evaluation of a national healthcare strategic framework.

Figure 1.3 is a clear example of a contemporary process flowchart in existence striving to reinforce a patient-oriented philosophy in relation to hospital safety parameters.

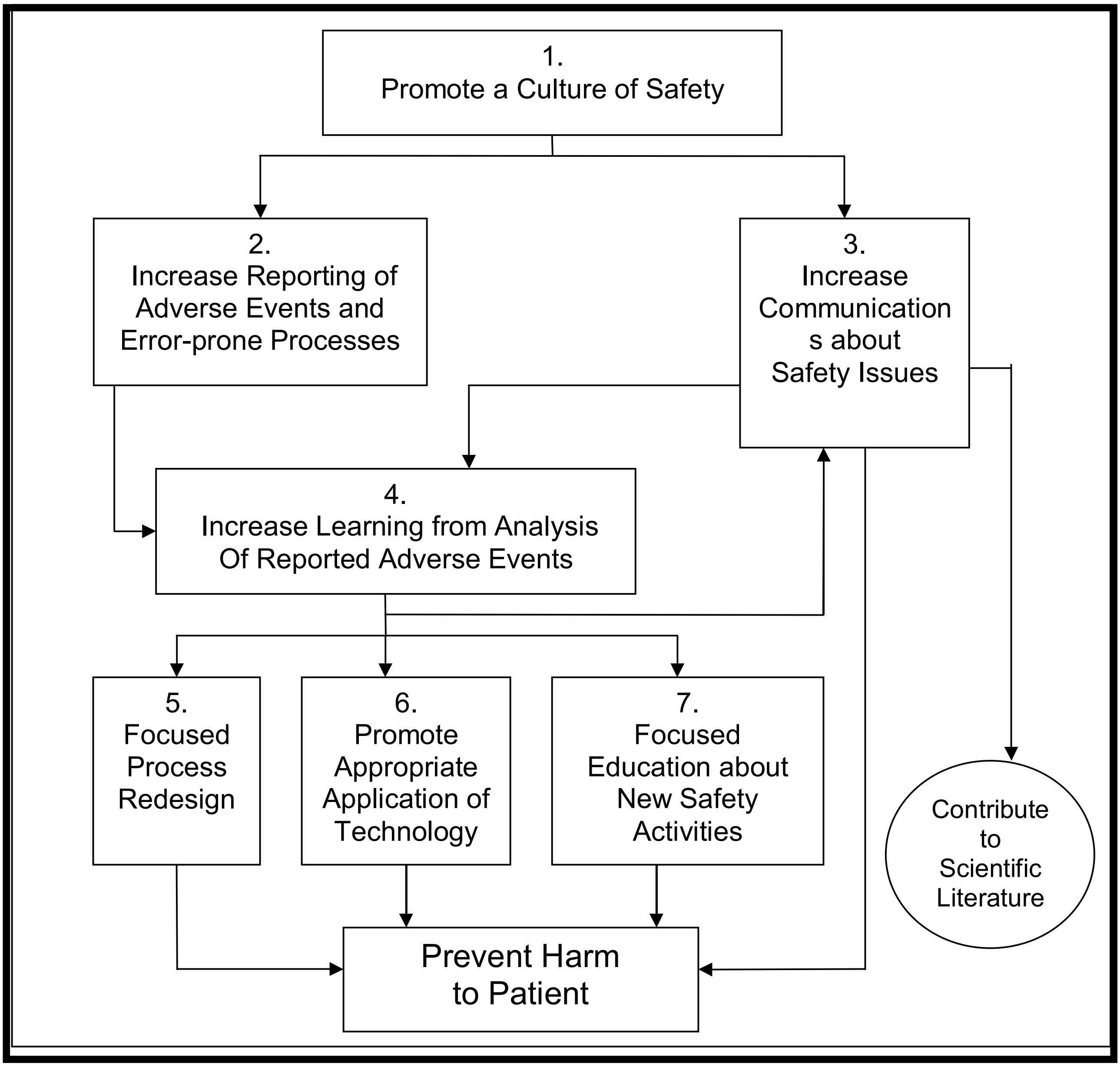


Figure 1.3: Preventing Harm to Patient: A Hospital Safety Procedure (Gelder, 2006).

The measures of this study's novel approach, however, would provide optimal treatment available based first on the patients' needs and satisfaction record and then on the healthcare organisation's resources criteria

1.4 Hypothesis

If a healthcare flow framework could support primary ontology-based, patient-oriented transactions and processes with healthcare quality measurements, then the result of this study could provide scientific grounds for a comprehensive, process-designed, decision support system for clinical and business users in healthcare to turn data into relevant, timely and useful information. Potential interoperability of this system's data with e-business intelligence technology to a healthcare central core of information will support real-time patient flow needs on all healthcare levels. Such an ontological approach could also be used as a scientific reengineering tool for benchmarking performance of core healthcare processes and transactions of the patient flow.

If a national healthcare framework follows the above hypothesis it will be in a position to empower decision makers, specifically elective patients. An innovative, ontology-based, performance framework that hierarchically integrates all necessary clinical, administrative and communication transactions for healthcare payers and providers could provide the necessary patient-oriented structure for the performance evaluation of this study's patient-oriented healthcare conception.

Healthcare, activity–based transactions could evaluate the quality level of this study's concept and during its implementation stage they could monitor cost versus quality results. If certain conditions of the patient flow are being traced over a period of time through a meta-data analysis, valuable information could be provided regarding measurement results for the system's successful implementation. The accuracy and cohesiveness of the measurements in a central, national database could be accomplished through the application of ontological theories (Samson et al., 2004). Ontology is an explicit specification of a conceptualisation. The term is borrowed from philosophy, where ontology is a systematic account of existence. When the knowledge of a domain is represented in a declarative formalism, the set of objects that can be represented is called the universe of discourse (Haux et al., 2003). This set of objects and the describable relationships among them are reflected in the representational vocabulary with which a knowledge-based programme represents knowledge. Thus, in the context of AI, we can describe the ontology of a programme by defining a set of representational terms. In such ontology, definitions associate the names of entities in the universe of discourse (e.g., classes, relations, functions, or other objects) with human-readable text, describing what the names mean, and formal axioms that constrain the interpretation and well-formed use of these terms. Formally, ontology is the statement of a logical theory (Split et al., 2002). The problem domain of this study is that if one asks which classifications should be used in a benchmark taxonomy that ultimately describes ontology-based information technology, Aristotelian questions are raised.

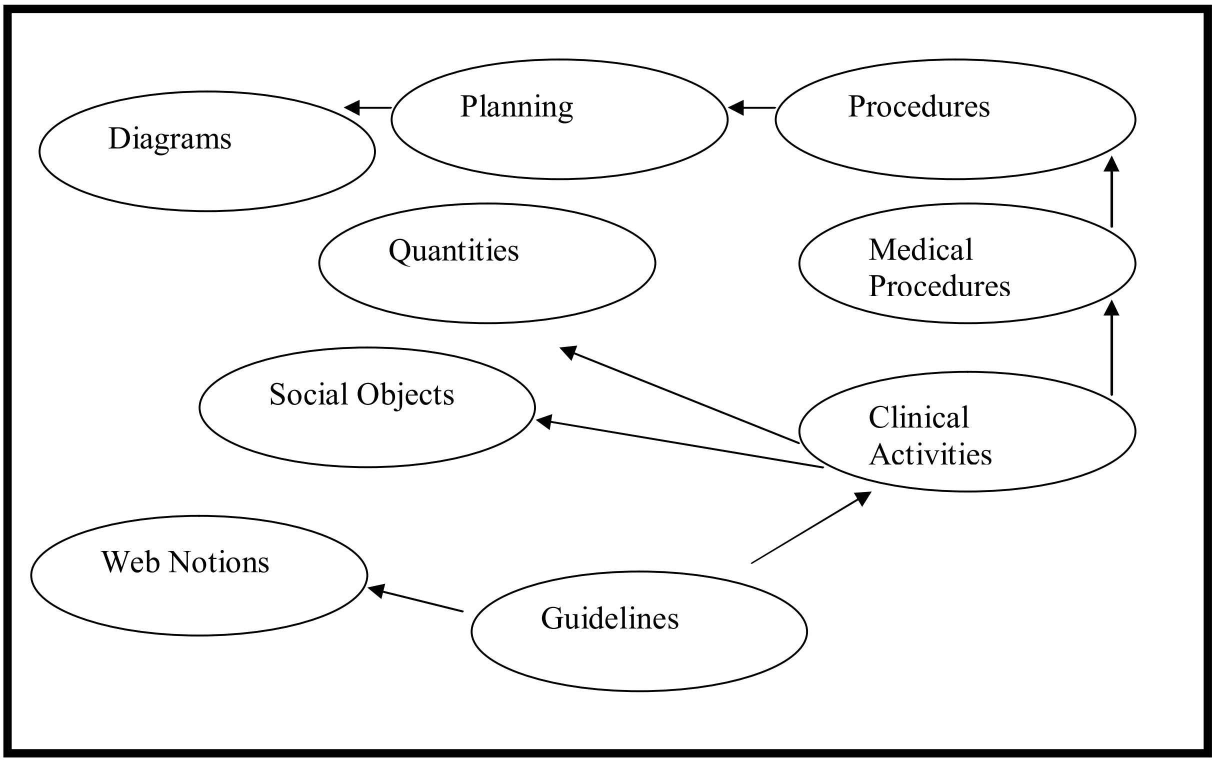


Figure 1.4: Ontology's Example

In philosophy, ontology comes from the Greek word "óv" which is something that exists and "λογία" which is the study of something. Thus, ontology is the study of existence. It seeks to describe categories or relationships of existence and to define entities within this framework. Ontology can be said to study conceptions of reality.

Figure's 1.4 terms are representing an "on". For example the "on" of the clinical activities could be found in the SAGE (Standards-Based Sharable Active Guideline Environment) Stanford study of the protégé knowledge base. The clinical activities become ontology by computing Clinical Practices Guidelines (CPG) and being validated by simulating the management of patient cases according to these formalized CPGs (Smith et al., 2001).

Under this study's strategy, a successful redesign of the healthcare patient flow process on a national level is possible once ontology is introduced. The new ontology-based transactions of this flow process will focus on measurable patient-oriented transaction results through the healthcare system rather than on the patient transaction activities at each healthcare level.

1.5 Organisation of the Study

The study is organised in five levels of analysis as exhibited in the organisation of the study (Figure 1.5). The first level, the prologue, encompasses one chapter. In chapter one, the historical background of the problem is presented and described as well as the aim and the objectives of the study. The study's hypothesis is also set out in this chapter.

The second level is relevant to the literature review chapters. This level of analysis consists of two chapters. Chapter two provides the literature review with the theoretical parameters that are covered throughout the study. This chapter analyses the consumer-oriented processes and systems that are essential for the understanding of the basic definitions and theories used. It also provides a literature review on contemporary commercial and industrial practices and information support of such frameworks. Consumer-focused, practical examples as well as theoretical approaches analysing all relevant terms and information systems, efforts and strategies for the introduction of an ontology–based framework for a patient-oriented flow are also introduced. This consumer-oriented literature provides secondary evidence for the introduction of such practices in healthcare. Then patient-oriented processes and measurements, healthcare measurement principles and definitions are also presented based on ontological principles as well as contemporary healthcare patient flow theories. Finally geographical reviews and contemporary efforts towards patient-focused healthcare performance systems throughout the world are presented. This domain is reviewed taking into account the regional and in some points national parameters that are very important for the development of such frameworks. It critically reviews contemporary systems' analysis and development studies and presents the core selection criteria through the analysis of two current patient-oriented measurable frameworks. It also exhibits the need for the introduction of a newly developed, patient-oriented performance framework. Finally, in the third chapter there is the definition of the research problem based on primary research results. It also describes the research methodology and introduces the system's methodology for design, redesign, analysis and implementation that are used for the purpose of the study.

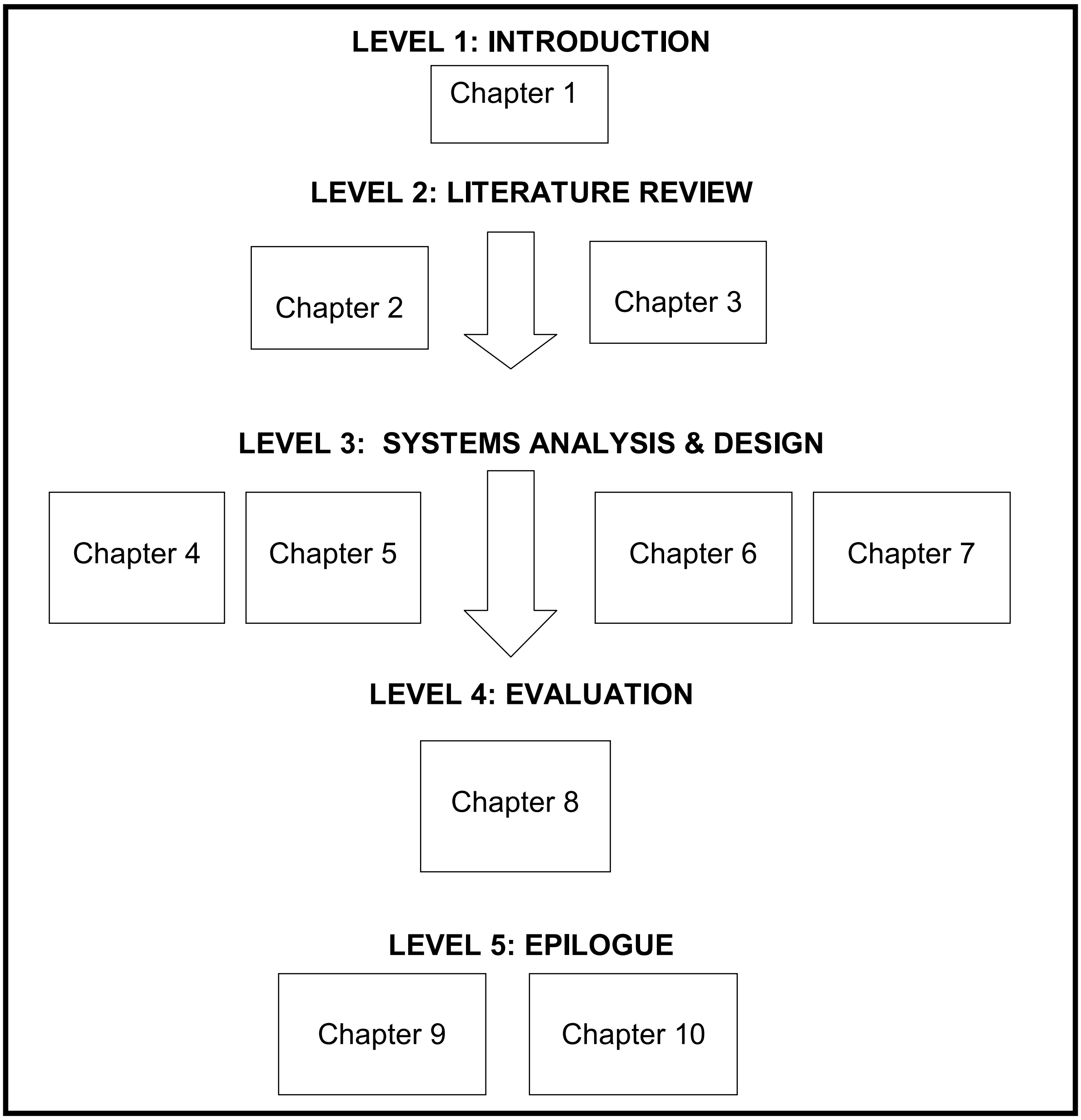


Figure 1.5: The Organisation of the Study

The third level continues this study with the system analysis, design and redesign of a new framework. It also presents the need for this Object System (OS) or framework. This level consists of four chapters. Chapter four contains the systems analysis and design methods as well as a historical review of the ontological methodologies including the adopted methodology. Then chapter five introduces ontology systems analysis, and it also assesses the needs for this study's redesign. It analyses the background of the current situation with additional supporting primary evidence in an effort to further discover the necessary needs and requirements for this study's redesign. Finally, it analyses the using system, process flow process, and then it devises its specifications for redesigning. Chapter six exhibits the design of the object system. It introduces the novel ontological model and its supporting information system, which includes leading measures for the model's design. It also introduces the measurements' linear equations which govern the direct relationship between the model and its supporting information system for the purpose of this study's framework concept implementation. Then, chapter seven concludes this level with the implementation of this ontology-based framework in CLIPS technology, introducing the interactive measurements' result reporting from the supporting information system as well as the action rules, which permit the ontological model's flow indicating the direct, interactive and dynamic nature of this framework's design.

The next level is the evaluation level. Chapter eight reviews evaluation methods and describes the adopted evaluation method for the purpose of this study. It concludes with the actual evaluation of the patient -oriented framework.

The final level of this study, which is the epilogue, includes two chapters, chapter nine and ten. Chapter nine summarises the conclusions of this study's nature, concept and its implementation contribution through practical case examples. Chapter ten discusses and proposes further work relative to the concept and framework design of this study.

1.6 Summary

Escalating healthcare costs are already impelling the industry to explore new paths that will improve the quality of patient-care and reduce errors that cause fatal results for patients and increase healthcare costs. Both private and public initiatives have motivated the research community to develop new models to improve the industry's efficiency. There are several studies focusing on systems supporting the delivery of healthcare services. There are also studies that focus on the way that business models are going to be applied in the sector by identifying the strengths and weaknesses of each one of them.

Although these studies are improving the healthcare industry, there is significant potential for new developments especially in the domain of patient-oriented, management performance systems. Identification of some problems in the Greek healthcare system provides a strong motivation to explore the possibilities of a solution based on the collaboration of the healthcare organisations at all levels and the EPR for the region aiming at the optimisation of patient satisfaction level and treatment.

Based on this research concept, the aim and the objectives of the study are set. The target is to maximise patient service value that could be achieved if the studies that have already been applied as pilot studies in the healthcare industry are studied both at the national and international level. Through these pilot studies and with the critical review of these healthcare studies implemented as they relate to this subject, this study could lead to a new solution framework. The identified similarities or the lack of them could produce a redesigned model for application to and further examination of the healthcare industry. The next chapter will present global efforts in this industry. The relation between consumer-oriented and patient-oriented strategy and systems will also be presented as well as the common practices in reengineering for both commercial and healthcare industries. It is imperative, however, to start with the next chapter that focuses on the research methodology used for the purpose of this study.

Chapter 2 Literature Review

2.1 Introduction

The importance of consumer-oriented business over the last two decades is unquestionable in the business world. Enhancing consumer value, delivering a value-added, quality service, is of major importance for any organisation's ability to grow in the business world successfully. Well structured business processes with the right information technology and data management support are imperative ingredients for business success (Assael, 1998).

In the healthcare industry as in all the industries around the world, similar principles and practices are starting to emerge. Patient-oriented concepts are also trying to find their approach in the healthcare industry using information technology. In this chapter, the roots of such business processes and their results, knowledge sharing and information, will be examined. Technology also assists an organisation in conserving knowledge in its database regardless of the system users. Information technologies, regardless of the industry practiced; aim to improve organisational processes (Spencer, 2003).

The management perspective on information interpretation requires exact meanings of conceptual terms before completion of any organisational transaction. Process quality improvement frameworks need also continuous monitoring through ongoing data collection, evaluation, feedback and improvement programmes. Many systems throughout these years have been developed to support such managerial modelling efforts (Davenport, 1999). The management system that supports such quality activities also has different angles of approach (US Department of Health and Human Services, 1999). There is great complexity in the interaction between the managerial model and the supporting information system in use. The problem domain of this study, that concerns the redesigning of the patient flow framework, has a number of distinct characteristics. The patient flow should be designed to enable flexible patient-oriented transactions that focus on patient treatment results, case by case, using the science of ontology. Through ontology a strategic gap that has been observed with regard to common practices and standards, that might be significant, could be bridged. Such strategic issues are quite important in order to establish common ground for analysing and evaluating healthcare practices (Healy and McKee, 2003). Rather than taking a historic approach to the subject, a number of the most recent and successful instances will be described in this chapter providing representative examples of this study's concept across a range of geographical settings.

2.2 Consumer-oriented Strategy Review

Organisational strategy is delivered through vision, mission and objectives in regard to the internal and external industry environment (Hamel and Prahaland, 1994). There are driving forces that are in need of strategic orientation throughout the organisation such as globalisation, information technology and knowledge. Thus, consumer-oriented strategy definition should encompass all the above strategic parameters in its processes, which will focus primarily on consumer relation and satisfaction (Ulrich, 1998).

There are many processes in an organisation's structure. Some are considered primary, and some are considered secondary. In a successful, strategic orientation, at minimum, all the primary processes should be coherent in their interaction with the organisational mission and objectives. The consumer-oriented processes mapping of the core processes mirrors the primary analysis of a business strategy (Kaplan and Norton, 1996).

2.2.1 Consumer-oriented Processes versus Product-oriented Processes

According to Maslow's hierarchy of needs (Maslow, 1943), once the consumer satisfies his or her physiological need, a higher level of needs occurs. An organisation-oriented processing focuses on each process at a specific consumer need according to Maslow's hierarchy (Nolan, 1999):

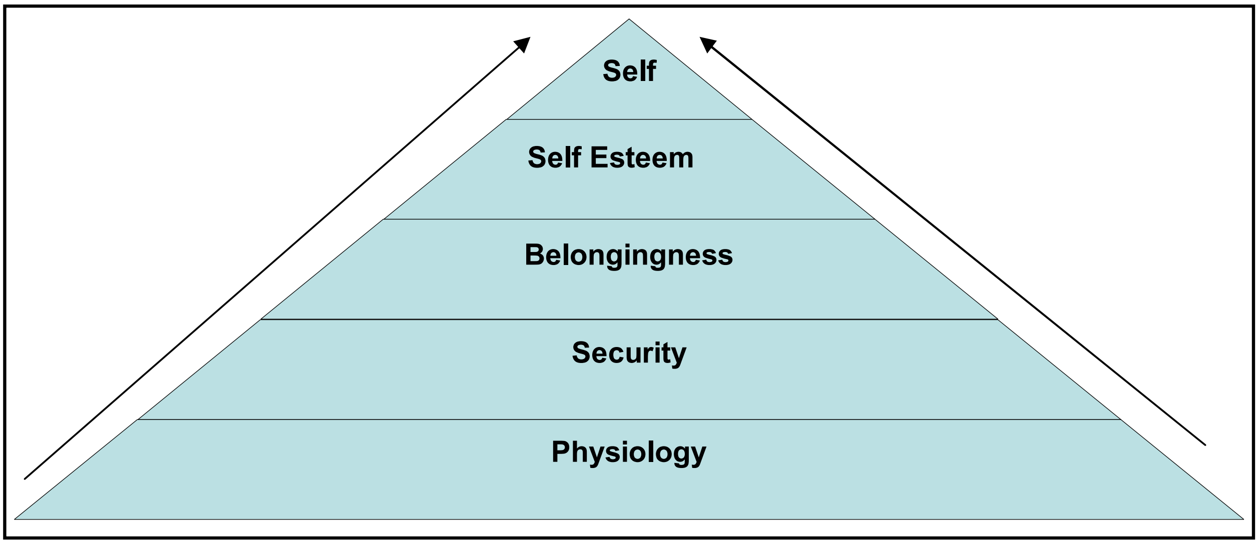


Figure 2.1: Maslow's Hierarchy of Needs

Turning an organisation from product-oriented to consumer-oriented demands a great deal of effort and a strong will, as there are several structural and informational parameters that have to be tackled (Kaplan and Norton, 1996). Processes are of a critical importance as they ensure efficient and effective operation, once they integrate all business aspects. The price that the consumer is willing to pay is expressed in the contemporary business world with the term value-added. A value chain analysis that follows in this chapter will further analyse this term. Product is as important, as it provides the necessary value to the consumer (Gareth et al., 2004). Table 2.1 exhibits the new needs in relation to the redesigning of primary processes as corporations pass from the industrial- to the information-era (Naisbitt and Aberdene, 1990).

INDUSTRIAL ERA NEEDS	INFORMATION ERA NEEDS
Hierarchy of command and control	Flexible organisation at any level
Direct, personal contacts for communication	Digital communications
Group planning management opportunities	Group execution of business
Stable organisation of business	Digital (dynamic) business
Business activity between 9:00 – 17:00	Business activity 24 hours a day, 7 davs a week

Table 2.1: The Transformation Needs from the Industrial to the Information Age

Transaction-management and marketing focuses on product statistical data. Relationship-marketing focuses on the consumer's transactions based on statistical data. Consumer-centric data are now required rather than the transactional data. The concept of such redesign is exhibited in figure 2.2

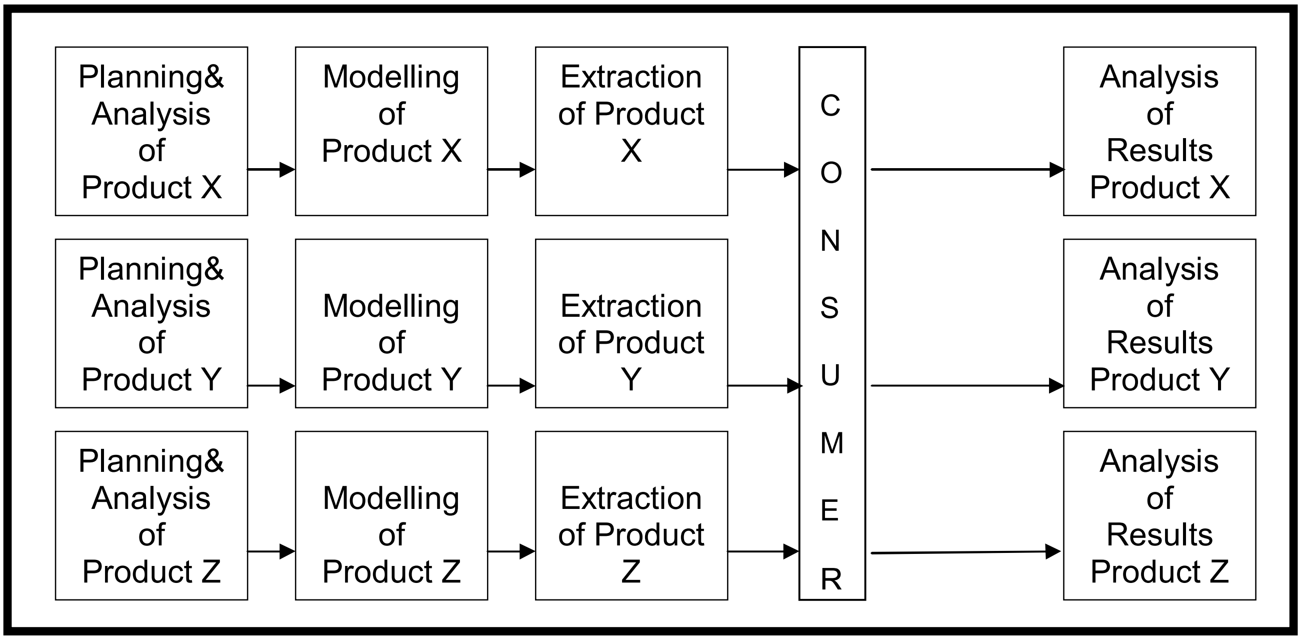


Figure 2.2: The Product-oriented Process

The process exhibited in figure 2.2 damages the organisation's profile, as there is no target group that can be seen. Such a process for the organisation is costly, poorly and ineffective. Figure 2.3 exhibits a consumer-focused management and marketing.

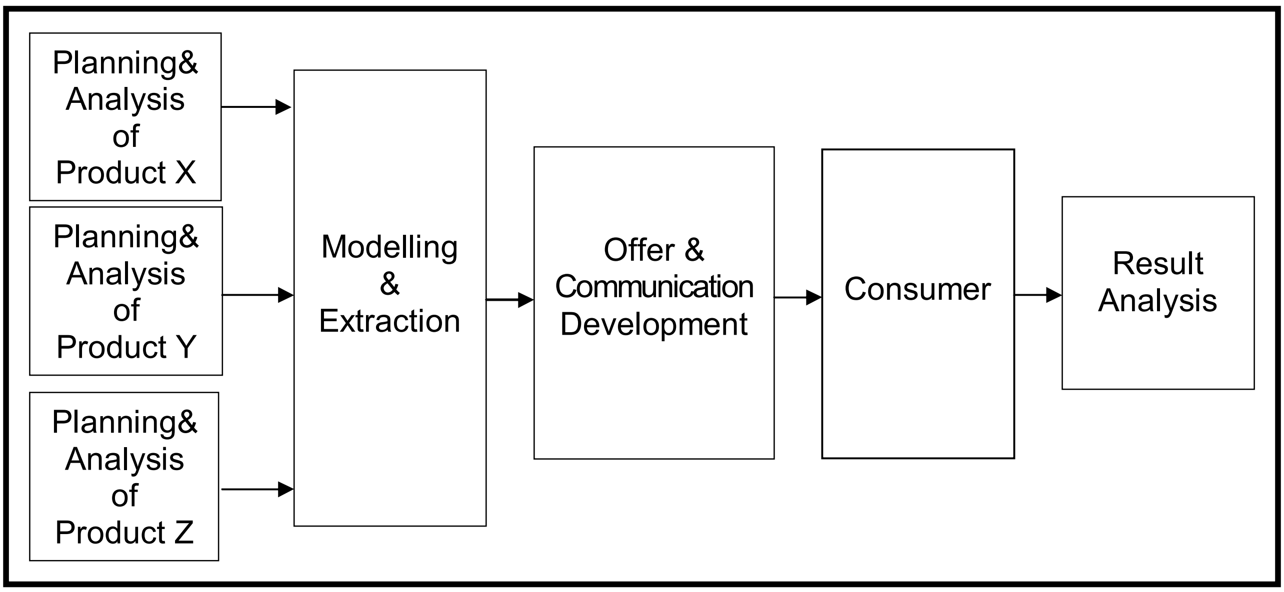


Figure 2.3: The Redesigned Consumer-oriented Process

Figure 2.3 demonstrates how such an approach provides the organisation with the opportunity to follow, customise and even design services to targeted consumers (Papagiannis, 2001). This value chain approach to redesign focuses on the organisation as a series of processes that create value for the company's products or services. Value is measured as the margin created above the total cost generated for the implementation of all primary and secondary activities. If the value of the organisation exceeds the total cost then that is the value of the service that the consumer is willing to pay. This value actually sets the right price for the product or the service. Porter separates the processes, or rather the activities of an organisation (Porter, 1998). It depends on the organisational philosophy how value will be encompassed by those activities. One thing is certain: that the value should be there to generate the company's competitive advantage. The following figure shows the Porter's value-chain of these activities:

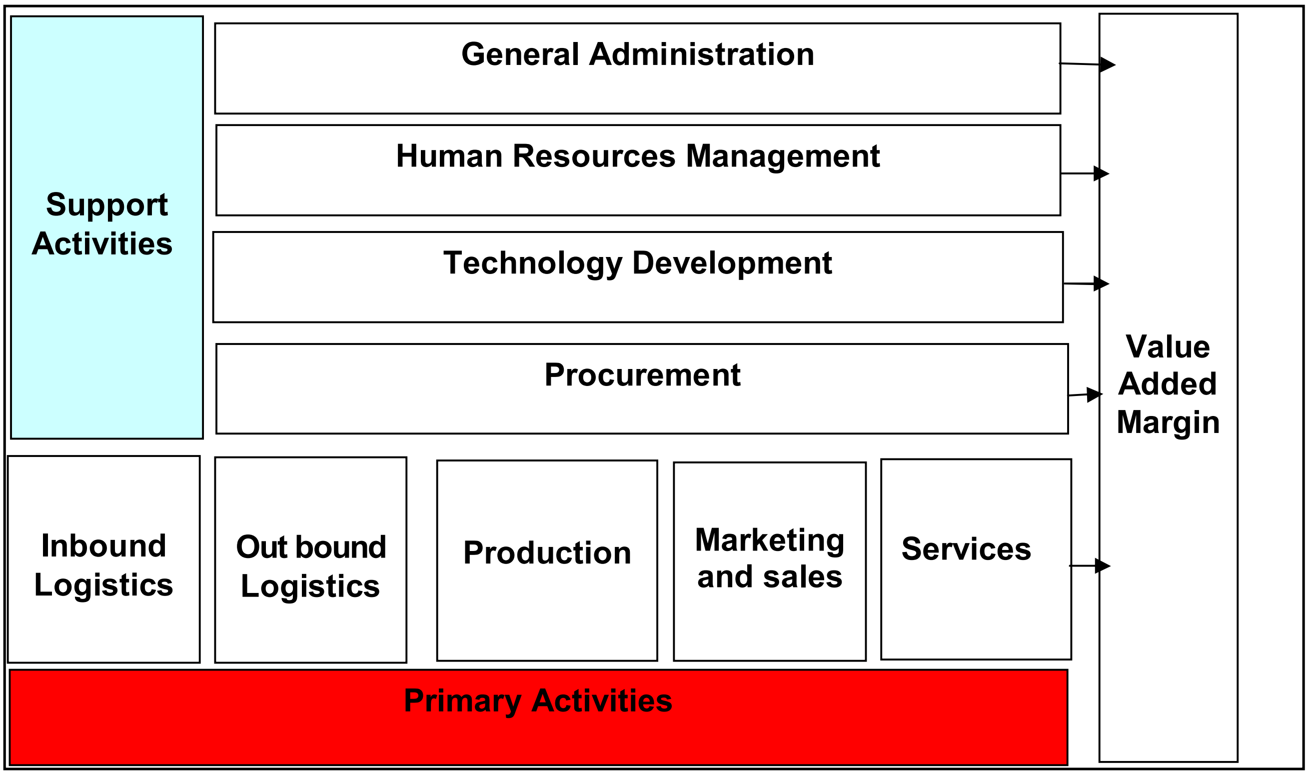


Figure 2.4: The Value-chain: Primary and Support Activities

On the other hand, many redesigning implementations towards consumer-orientation fail due to lack of stakeholders involvement (Blyler and Coff, 2003).

Thus, it is important for the researcher also to take into consideration the system's actors. Then, he has to follow specific measurements to comprehend if the strategy is effective (Simmons, 1995). An example of such practices that measure performance based on consumer related issues is shown in figure 2.5:

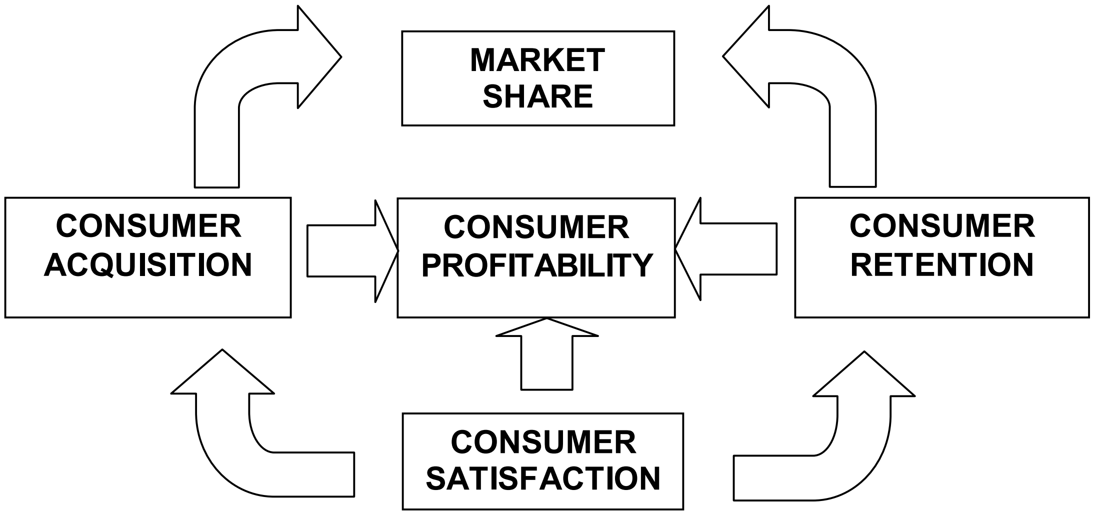
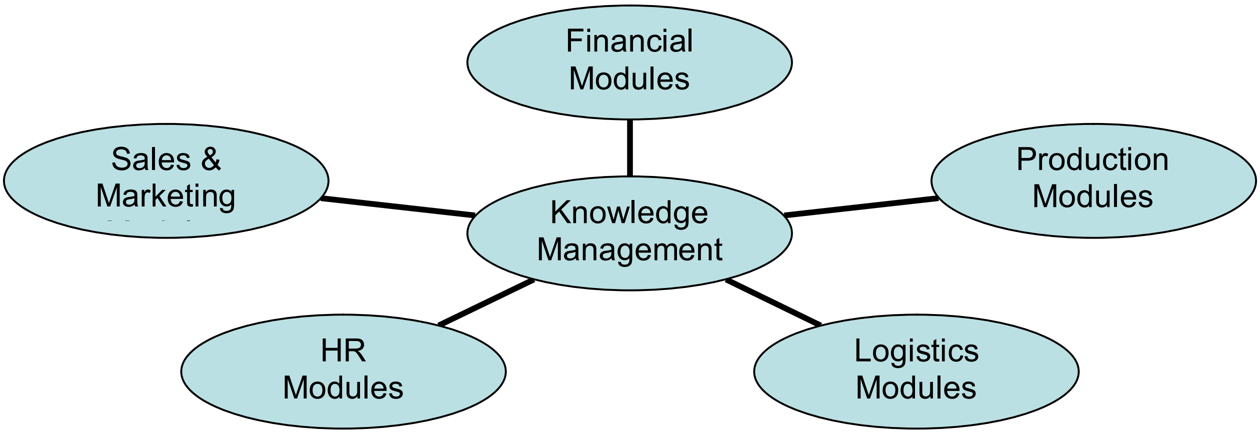


Figure 2.5: The Consumer Perspective-Core Performance Measures

These consumer relationships define a consumer-oriented strategy and thus encompass long-term objectives as well as value commitment (Heskett et al., 1994). This section analysed all the necessary parameters that should be taken into consideration for the introduction of consumer-oriented frameworks. The next section will introduce the necessary information tools and infrastructure for the implementation of such frameworks.

2.2.2 Consumer-oriented Models and Supporting Information Systems

Figure 2.6 exhibits the internal relation of the knowledge management and information systems with the enterprise resource planning system:



Enterprise Resource Planning

Figure 2.6: Information Management and Enterprise Resource Planning

There are many approaches to the architecture of MIS in an organisation. The basis to approaching such systems should be human. Human-centred systems should guide the efforts of embedding technology into an organisation. The MIS parameter and its philosophy are very important for the use and sharing of the information system (Adelman, 1992). In the healthcare industry, as later chapters will prove, there is still a lack of consistency on very important pieces of medical information systems. There are two forces affecting the management of information flow politics in every organisation: information globalism and information particularism (Lederer and Sethi, 1998). Information globalism always seeks ways to translate data in a way that has meaning for the entire organisation. Information particularism tries to translate data in a way that has meaning for a specific group of users. Thus, there is always an issue of information politics affecting information sharing and interpretation. A human-centred approach thus enables the appropriate behaviour and culture in the organisation that should also focus on human resources and not just the organisational model. In an ERP, once the information enters the system it can be available to all users regarding their department. Figure 2.7 shows the current situation in industrial practice and thus is directly relevant to the content of this research.

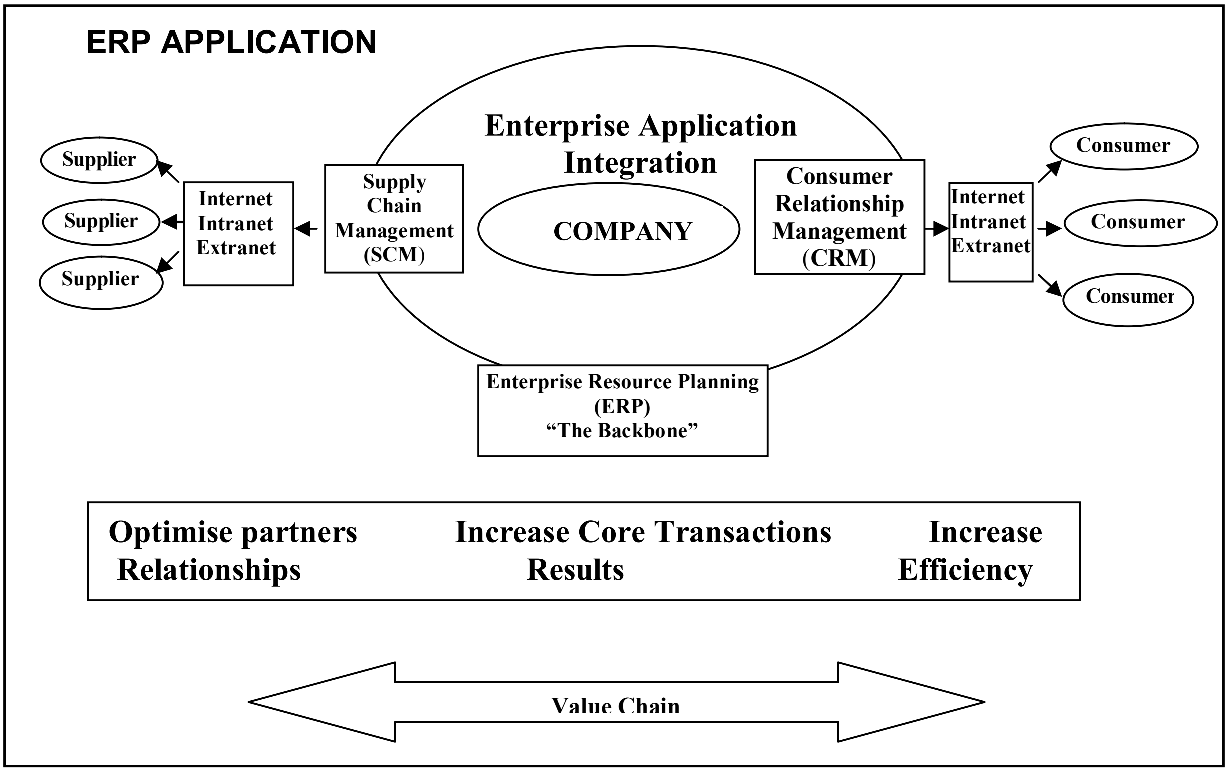


Figure 2.7: The Extended Enterprise

Figure 2.7 has three categories: the internal facing system, consumer facing systems and the supplier facing systems. These systems are directly relevant to the primary business processes of the value-chain model. They are also relevant to the primary business processes of an organisation. All of these systems aim to establish value-added transactions for the organisation's processes (Norris et al., 2000). The information flow in managerial hierarchy is a serious issue in organisational modelling. Any organisation can operate as an overall enterprise (centralised model) or as an autonomous organisation (decentralised model). Figure 2.8 exhibits the hierarchy of this flow from the input point to management value-added decision-making:

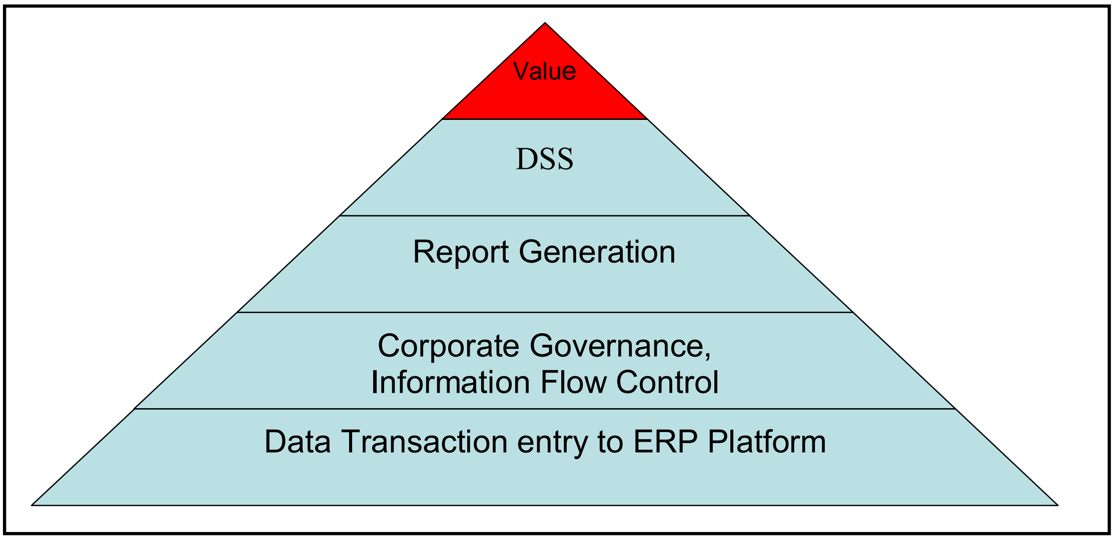


Figure 2.8: The Information Flow and Managerial Hierarchy

Usually, regardless of the organisational functionality, information flow is integrated in the business value-chain across all organisations that belong in the same group (Groth, 2000). Some of the most important modules embedded in ERP systems are the supply chain management, procurement, advanced planning, management requirement planning, logistics, budgeting and consumer relationship planning. The above modules assist in the industry value-chain as well as in the internal organisation value-chain supporting the primary processes of the organisation. Figure 2.9 exhibits the industry value-chain and its consumer relation:

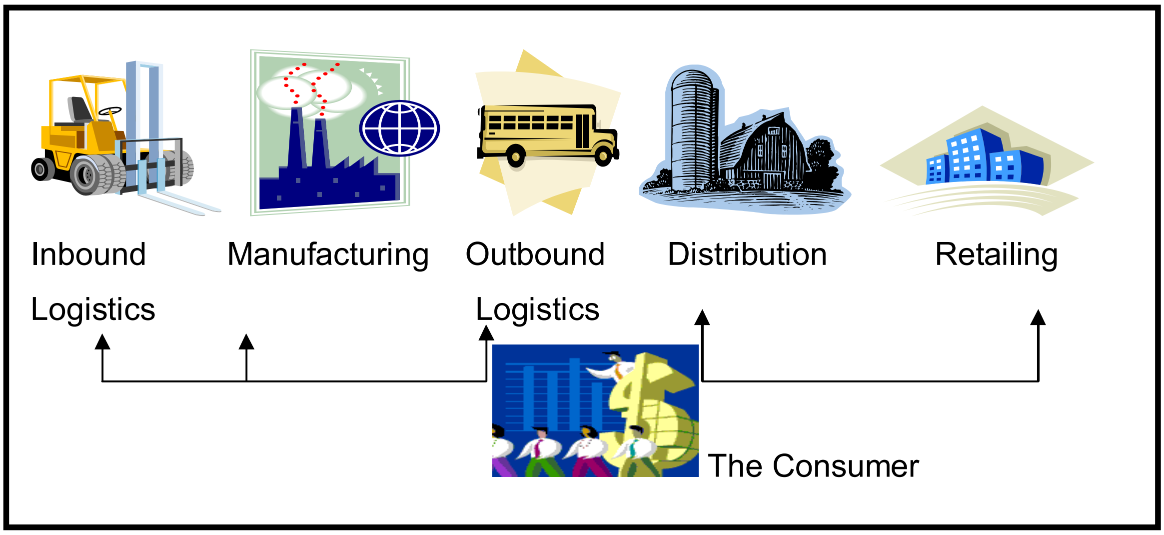


Figure 2.9: The Industry Value Chain

It is obvious from figure 2.9 that the CRM process is one primary process that adds value in the value-chain of a consumer-oriented strategy. Figure 2.10 exhibits the consumer relation process that is a major stepping-stone towards successful implementation for industrial consumer-oriented strategies in (Curry, 2000).

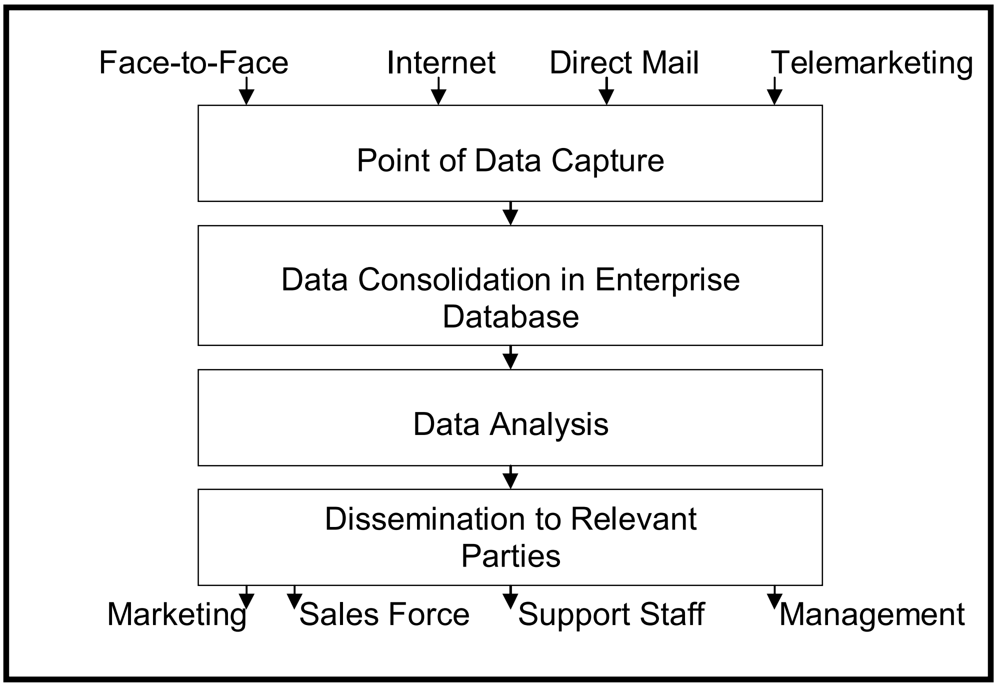


Figure 2.10: Consumer Relation Management Process Diagram

Figure 2.10 analyses the required process that has to be designed and included in the CRM module. The same warehouse methodology is followed in most of the modules that have to be embedded into an ERP platform (Papagiannis, 2004). In recent years, information technology has been assigned to implement the business processes in application systems logic. These efforts resulted, in the third generation, ontology–based, systems that allow the business experts to define business processes in a knowledge base, which is based on ontological modelling. Gartner and Forrester characterise ontology engineering as a core, knowledge-modelling activity that will have a great effect on many enterprise applications and knowledge integration in the years to come (Fensel et al., 2003). Thus, ontological knowledge could supplement the above types of knowledge with the important difference of containing the concept of class as well as categories of things in that knowledge domain and the terms people use to talk about them (Sowa, 2000).

2.3 Principles of Patient-oriented Information Systems and Processes

For the purpose of this study several definitions and principles relative to patient-oriented practices have to be introduced. Patient satisfaction is defined as a comprehensive measure that reflects the patient's perceptions concerning mortality rates, functional status measures, well-being, cost etc (Epstein, 1998) and thus may provide the most inclusive or exclusive measurements for the object of the study . For the purposes of this study, patient-oriented process is defined as diagnosis, treatment and intervention research using patient-oriented measurements. Economists and health economists have been debating international comparisons of health expenditure for more than 30 years beginning with significant studies by Abel-Smith (1967) and then Kleinman (1974) and Newhouse (1977). This study will focus on the design of a patient-oriented framework, which will include the necessary transactions and results which will be supported and evaluated from an information system that will consider all the introduced measures presented above.

Consumers and patients are heterogeneous in nature. They have different sets of values and parameters to consider when they evaluate a specific service being offered. Patients, after all, are in the unpleasant situation of bearing a health issue that has to be treated. The introduction of relevant communication values, primarily social, and measurements to healthcare information management frameworks is an important issue in this study. In order to build the necessary quality into the primary healthcare processes focusing on the patient flow, information process and organisational model redesigning should occur.

2.4 Historical Review of Patient- Versus Healthcare-Framework Designs

The first healthcare quality standards that were established as minimum requirements for quality were introduced for the purpose of organising hospital medical staff, limiting staff membership to well-educated, competent and licensed physicians and surgeons, framing rules and regulations to ensure frequent staff meetings as well as keeping medical records that include physical examination, history and laboratory results (Roberts et al., 1987).

Historically, there is a direct correlation between patient and healthcare. The difference between healthcare versus commercial frameworks is though their application. Healthcare orientation is mostly dependent upon inflexible quality principles and measurements to provide the best healthcare. On the other hand, a commercial framework is consumer-oriented enforcing continuous scrutiny of external parameters to ensure awareness of the newest ideas and principles. Figure 2.11 exhibits the complexity of the factors that have to be considered, regardless of the strategic orientation of the organisation, in order to define the healthcare product.

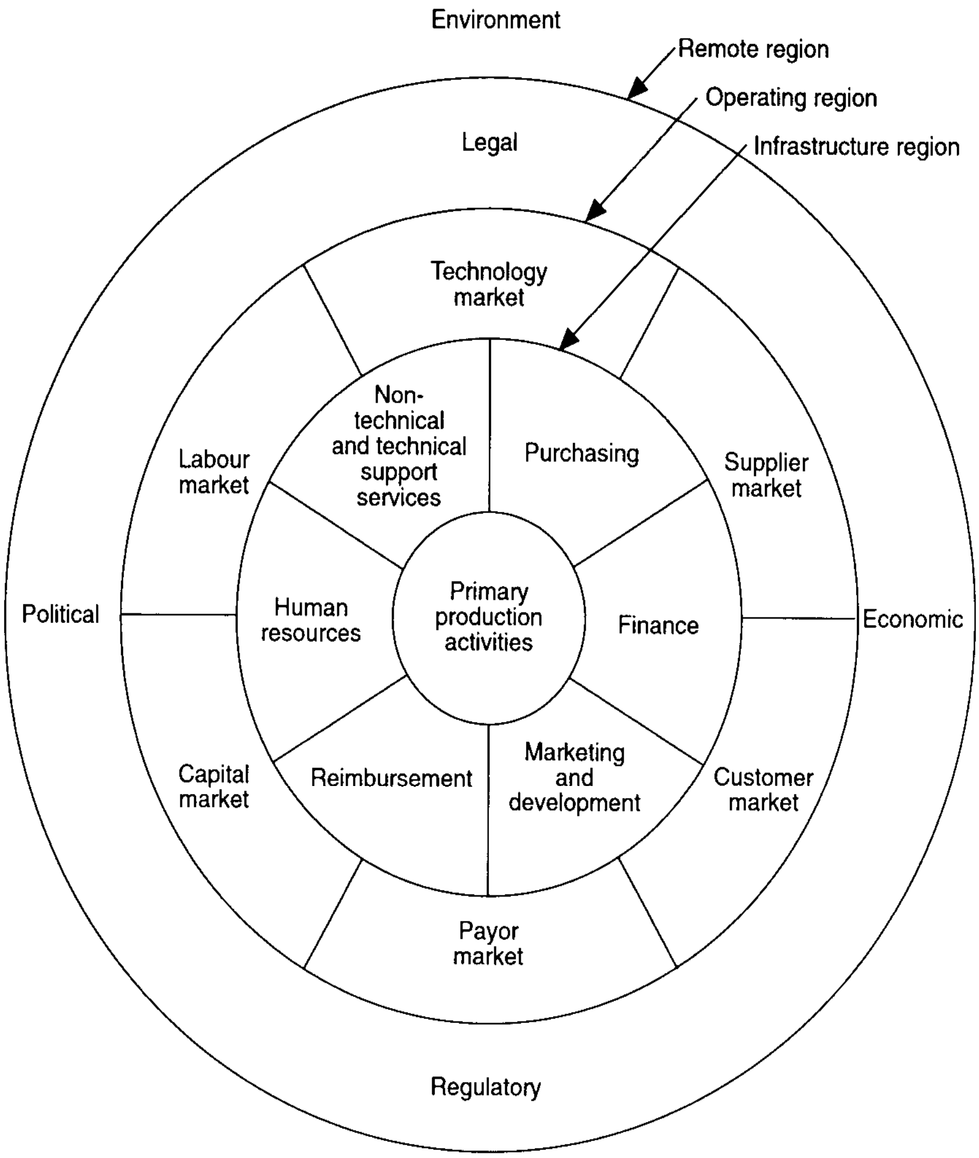


Figure 2.11: The Healthcare Product Definition (Swinehart et al., 1995)

Use of information technologies to generate individual patient and illness controls and BPR reports as of the early 1980s were widely adopted in commercial manufacturing. These approaches attracted the interest of managers in the NHS and two studies at Leicester Royal Infirmary and at Kings Healthcare in London (CCTA, the European Commission, 1994). Today patient-oriented flow could be scientifically, rather than practically, redesigned by principles of enterprise ontology methodology. According to analytical philosophy, ontology is understood, not as a software implementation or as controlled vocabulary, but rather as “the science of what is, of the kinds and structures of objects, properties, events, processes and relations in every area of reality”. According to Alfred Tarski’s “semantic” definition of truth for artificial languages, it is assumed that the language refers to a “world”, in this study that of healthcare, describing minimal conditions that this world must satisfy in order for a “meaning” or concept like healthcare orientation to be assignable to every expression in the language based on specific measurements. The semiotic triangle (Bunge, 1979) and the ontological parallelogram (Dietz, 2006) presented in the DEMO methodology chapter four of this study will lead to a state model of the patient-oriented ontological world expressing a form of this formal model technique of the mathematical model theory. The routing of the patient flow is examined and analysed based on linear programming methods. Such linear programming methods were used by researchers in an effort to solve the problem of the patient flow from the operational point of view (Wolstenholme, 1999). The core routing, where heavy traffic is in order, was depicted and monitored. The healthy people entering this flow as well as the population of treated people exiting this flow and their treatment progress was considered. Measurements provided from the supporting information system were used at each model’s transaction and on every patient flow route in an effort to measure efficient flow.

Finally, numerous market forces have influenced healthcare providers in the past 15 years (Figure 2.12). Looking at the success of integrated delivery systems, it is interesting to take note of the dynamic and changing nature both of commercial/ERISA margins and Medicare (Lansky, 2002).

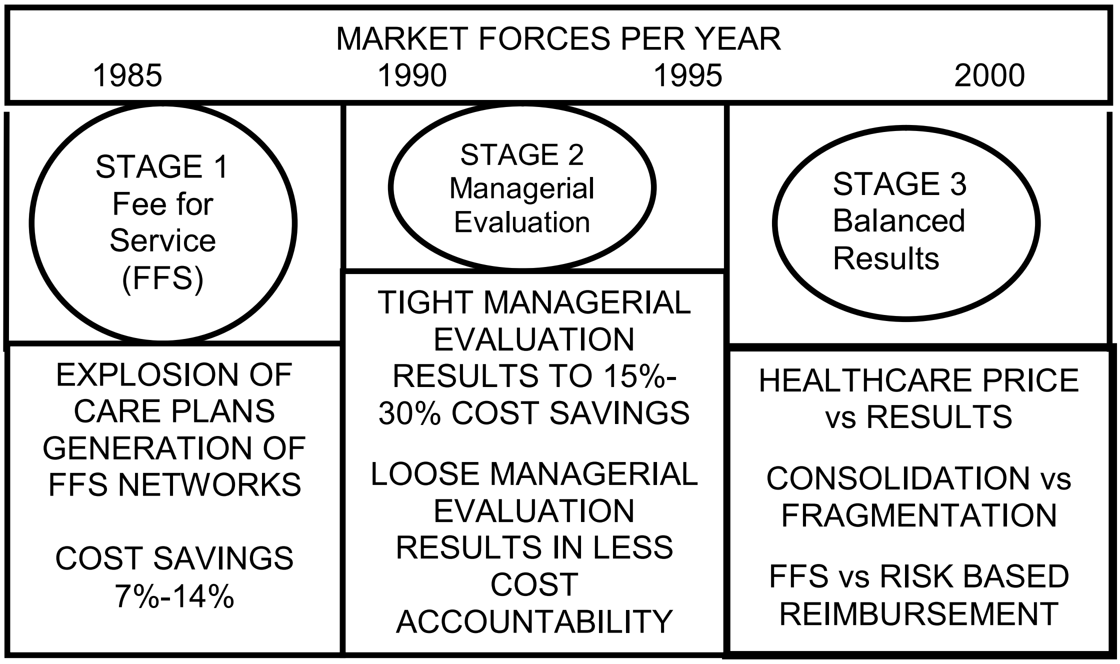


Figure 2.12: Market Forces and Provider Margins

Several organisations today drafted a strategic framework and developed web-based resources that are aiming to improve the objectives of making U.S. healthcare redesign more patient-centred (Schnonberger, 1986). At the same time, one of the USA's largest firms, NRC and Picker assisted more than 4,500 health researchers to conduct extensive interviews with more than 8,000 patients, family members, physicians, and hospital staff to uncover answers to questions such as what do patients want and value, as well as to what helps or hinders their ability to manage their health problems. The result is that, in order to decide properly, patients should be well-informed and monitored. To approach a European-wide solution of such complex interconnection as exhibited in figure 2.12, the European patient-profile study, MEDIREC, was initiated (www.sadiel.es). The MEDIREC study created the PROREC initiative, which is the creation of the European Institute for Health Records. These efforts matured, and there is currently the CEN/TC251, a Europe-wide agreement.

A synopsis of all the above parameters shows that a healthcare system should be responsible for patient well-being at all times (24 hours a day, every day). Examples of such technology providers are the Internet, the telephone and other means. Figure 2.13 provides an example of this philosophy: in patient-oriented healthcare framework, informed patients should receive care whenever they need it. Such a principle is currently stated as a continuous healing relationship. Patient-focused interventions, on the other hand, focus on empowered patients fulfilling the role of dynamic system actors in healthcare flow process by securing appropriate, effective, safe and accessible services.

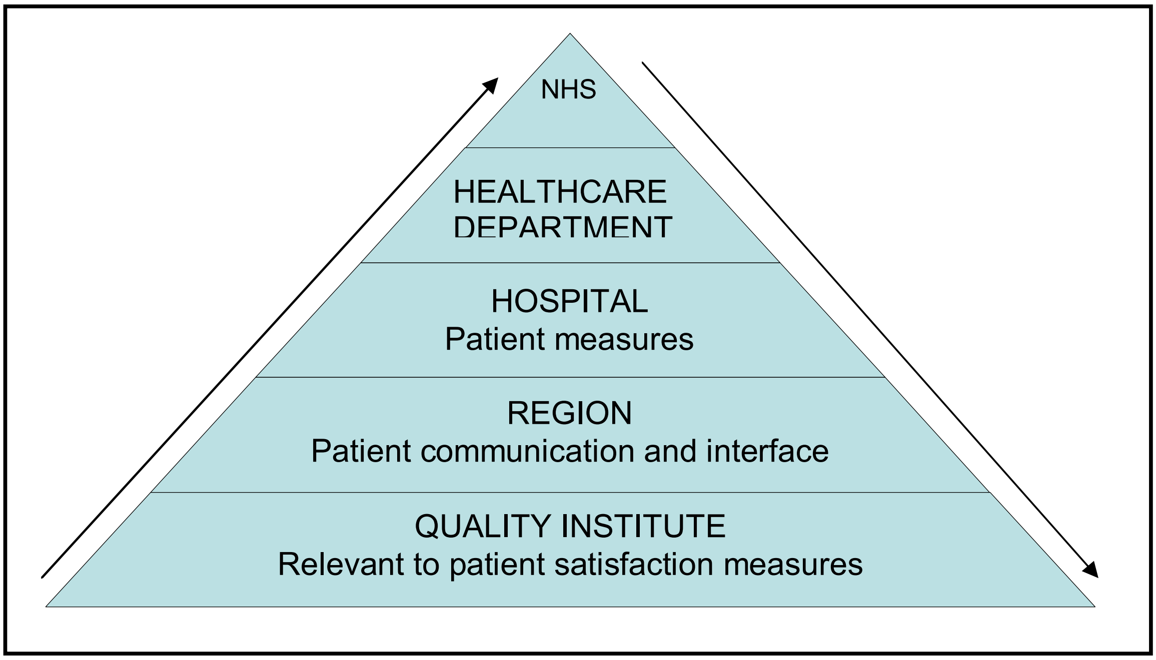


Figure 2.13: Patient Flow Allocation Process

Thus, in order to assess the effectiveness of patient-focused interventions, the QQUIP Study (Coulter and Ellins, 2006) grouped these interventions into four categories:

1. Patients' Knowledge
2. Patients' Experience
3. Service Utilization
4. Health Behaviour and Health Status

All the above categories are relevant to the measurement of performance of a healthcare system based on a patient-oriented concept that is the focus of this study as this issue remains scientifically unsolved. The designs of such measurement information systems historically were developed as a tool to align business models to a national framework's strategy (Purbey et. al., 2006). Performance measures should fulfil the following characteristics:

1. Sensitivity towards internal and external environmental parameters
2. Hierarchically categorise internal objectives according to environmental changes
3. Sustain quality results based on Business Process Improvement (BPI)
4. Ensure an overall processes accordance with the NHF strategy

Competition, patient service, joint ventures as well as continuous quality improvements require state-of-the-art measuring systems (Bititcti et al., 2000). Historically, some of the performance measure systems that bind processes to organisational strategy are the following:

1. Balanced performance measurement matrix (Keegan et al., 1989)
2. Performance measures for time–based completion (Azzone et al., 1991)
3. Performance Pyramid System (PPS). This system was originally developed by Judson (1990) and improved later by Lynch and Cross (1991)
4. Balanced Scorecard System (Kaplan and Norton 1992)
5. Brown's Input, Processes, Outputs and Outcomes Framework (Brown, 1996)
6. Performance Prism (Neely et. al., 2001)

The Balanced Scorecard System, adopted in this study due its relevance to the healthcare sector, argued that the problems of the traditional, performance measurement systems could be further improved if a commercial organisation adopts a balanced set of financial oriented and non-financial oriented measurements (Kaplan and Norton, 1992). On the other hand, the use of the balanced scorecard in healthcare industry is relevant, although minor modifications to reflect the industry’s environment are necessary (Zelman et al., 2003). Thus, this method or system is used by a wide range of healthcare systems, as it could be modified to include parameters, such as quality of care, outcomes, and access. It thus increases the need for accurate, comprehensive, and timely information. Patients must be more engaged as healthcare consumers ensuring, not assuming, that they are receiving high-quality care (Quality on Healthcare in America, Institute of Medicine, 2001).

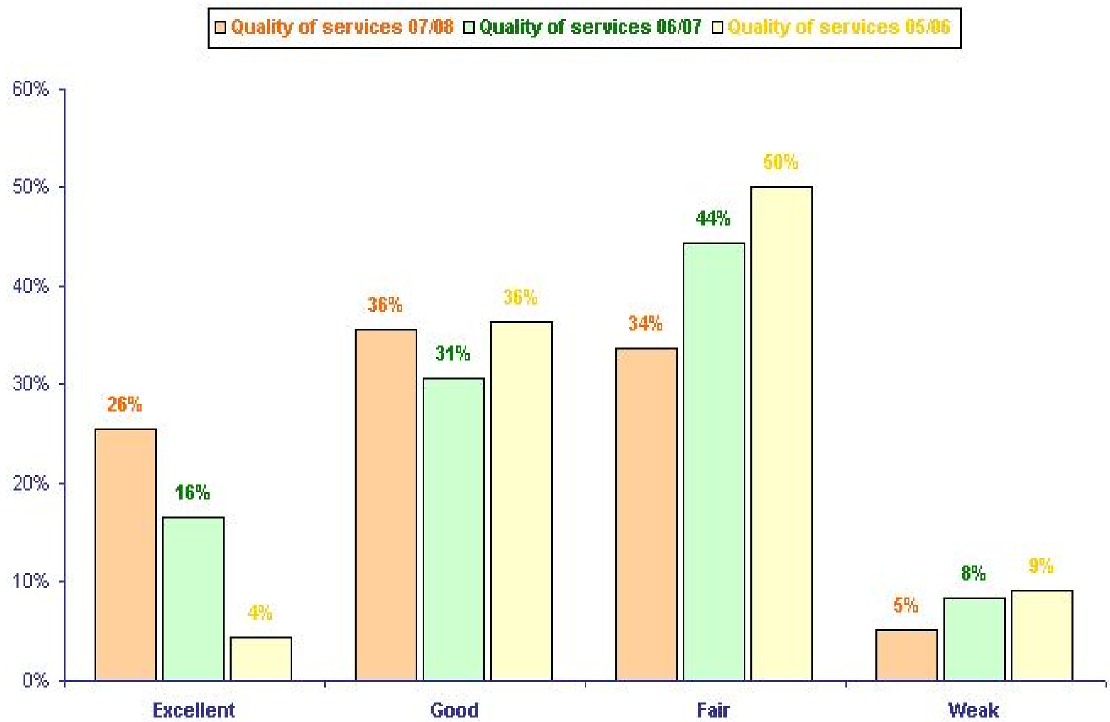
The next section, will further investigate the concept of this study as it will continue by presenting contemporary patient-oriented framework designs around the world.

2.5 Patient-oriented Framework Designs: A Global Approach

2.5.1 Europe

The World Health Report 2000 stressed that the organisation, configuration and delivery of services have an impact on the performance of the overall healthcare system. The current redesign of healthcare services among European countries – both Western and Eastern countries – highlights the importance of efficient healthcare throughout Europe. The development of new, common-policy orientations, focusing on quality improvement practices, systems and strategies and the growing interest in patient-satisfaction measurements are incentives for developing healthcare performance assessment frameworks. The methods used for quality improvement and performance measurement are practiced in countries like Denmark, the United Kingdom (Shaw, 2000), Germany and others like Greece (Moumtzoglou et al., 2000), Poland (Lawthers at al., 1999) and France (Hanson et al., 1993) showed that inter-hospital benchmarking is possible. It must be noted that there is a great difference between quality improvement and performance measurements for quality. Quality improvement satisfies necessary processes that could be applied in order to assure quality. Quality performance measures the degree that these processes are being implemented.

In 2008 the UK Healthcare Commission that is responsible for assessing and reporting on the performance of both NHS and independent healthcare organisations published, for a third consecutive year, a national performance overview of the NHS trusts' performance indicators, which showed an annual measurements improvement on the above different types of measurements. Specifically, as part of the 2007/08 annual health check, all 391 NHS trusts received a rating that consisted of a score for quality of services and a score for use of resources. Figure 2.14 exhibits that this monitoring, assessing and reporting process produces positive results in regard to the quality of services from 2006 to 2008.



Source: Healthcare Commission annual health check 2006-2008

Figure 2.14: Comparison of performance for quality of services over the lifetime of the annual health check

Another recent practical example of methods used for quality improvement and performance measurement in the patient-oriented services domain is the PAC (Patient Accelerating Change) study. The PAC study was a jointly supported initiative by Picker Institute Europe and the NHS. The study's aim was to provide ongoing support and guidance and to encourage networking between the UK and European organisations rather than to play an active role in local studies (CGST and Picker Institute Europe, 2003-2004). The purpose of this study was to improve communication and information and make patients feel that they are valued and listened to. These programs resulted in a publicised patient survey in 2008 showing significant progress on patient satisfaction (UK PCT Patient Survey, 2008). On the other hand, analysing the questionnaires' results further, patient-satisfaction areas such as time spent for discussion of a patient's problem, lack of patient understanding as well as long waiting hours need serious improvement.

The Danish, Swedish and the Finnish have similar approaches to patient-oriented practices. The Finnish public sector requires all public organisations, including healthcare, to implement a performance measurement system (Rantanen et al., 2007). They focus, as in the last decade they have developed a measurement system for following up lead times, similar to the Kanban system, in an effort to minimize queue time in the patient flow process (Kollberg et al., 2007). The Spanish approach is interesting, as this country is a Mediterranean one and people share common idiosyncrasies. In May 2003 a new bill on “Cohesion and Quality in the National Healthcare System” was passed in Spain. That bill stresses the quality issue for all private and public hospitals (Simon and Cruz, 1995). The French approach is a simplified version of the model developed by the University of Montreal. This model incorporates the achievement of goal, optimum use of resources and adaptability to change parameters. The French experience does not aim for a single model, merely for a framework to ensure that legitimate dimensions are included and available to participating hospitals (Kazandjian, 2002). On 2002 WHO provided guidance on policy orientations. When there is no star indication, the dimension is non-relevant and when there are three stars it is very relevant (see table 2.2).

Clinical Effectiveness	**Relevance**	**Feasibility**
Re-admission rate x days	***	***
Mortality	***	*
Complication rate	***	
Appropriateness	***	
Length of stay disease specific	***	***
Quality improvement progress	***	**
Evidence based processes	***	(*)
Patient Centeredness		
Waiting time (elective surgery)	***	*
Equity of access	***	
Patients rights	***	*
Patients perception	***	*
Production Efficiency		
Length of stay disease specific	***	***
Safety		
Hospital-acquired infections	***	
Falls	***	*
Bed sore	***	*
Staff Orientation		
Turnover	***	***
Absentee rate	***	**

Table 2.2: Analysis of Dimensions and Sub-dimensions of Hospital Performance: Relevance and Feasibility. Dimensions and Sub-dimensions (The World Health Report, 2003)

2.5.1.1 Greece: Contemporary Situation

In the Greek healthcare sector studies showed a substantial lack of effective patient-oriented practices as well as a lack of efficiency in general hospitals. In Greece cross sectional patient-oriented services remain to be applied. The critical healthcare parameters introduced previously, do not analyse the following equation that was taken into consideration in these studies: “equality > effectiveness> performance” (Tountas and Economou, 2007). Such an equation is important as it stresses once again the role of the public health, according to the single payer system’s aim, that should be available for everyone. This critical parameter should be taken into consideration for the concept of this study. The reason is that this section provides evidence that many national healthcare systems have different approaches to such an issue. For example the above equation that is proposed was first introduced as: “effectiveness> performance > equality”. The hierarchy in this equation shows a completely different approach proposed by Cochrane (Cochrane, 1972). It is, however, obvious that both approaches partly consider the equality issue for the healthcare industry. In Greece R&D is highly funded by the EU-R&D framework and is mainly focused on the field of health and care. This implies patient oriented services based on resources availability as well as collaboration services based on PACS, bridging physical distance among users (www.euro. who.int).

Currently, the situation in Greek healthcare is that almost 75% of patient admissions take place in public hospitals. Based on recent study (Papanikolaou and Ntani, 2008) with 367 patients that were hospitalised a minimum of three days at a Greek general hospital, patients had to wait long hours to get an appointment with a doctor. If for any reason this appointment was missed regardless of the reason the patient should reschedule. This long wait continued after their examination until they were admitted to the hospital. However, given the bad structural healthcare circumstances patient overall satisfaction was high relevant to the healthcare staff services. This recent primary research provides useful evidence for the purpose of this study on how patients evaluate their flow in Greek healthcare. Patients, as this study also indicates in literature review, are expected to act as consumers who carefully evaluate the aspects of care they receive. However, certain aspects of care which patients take for granted when they evaluate their experience relevant to safety and doctor's tacit knowledge need improvement. Patients' relationship with healthcare providers may reflect trust rather than informed choice (Papanikolaou and Ntani, 2008). Patients' bad experience, in accordance with the primary findings of this study, relevant to aspects of their care was not directly reflected in low levels of satisfaction. They considered lack of human resources and other hospital assets as the main drawback of the Greek hospital. As a result, many patients had to rely on personal nurses and pay additionally to the medical and nursing staff in an effort to receive proper care. Currently in Greece, besides the lack of a national healthcare framework, there is the structural problem of "ephemeria". This term defines a hospital that is indicated to receive emergencies n a 24-hour period. This issue, besides mismanagement, creates gaps in human resources and other hospital assets of the NHS. It is therefore impossible for a patient to receive immediate treatment in other hospitals except from those indicated by the public healthcare system as being "ephemerevonta" hospitals.

Another critical parameter to be mentioned in the Greek NHS is the interaction of the public insurance and the healthcare. As of 2007, tens of public individual insurance funds were proposing their own set of patient flow guidelines in order to provide public healthcare substitution. In 2009 these funds merged into four individual public insurance funds. "IKA" is by far the largest public insurance fund for public and private employees in Greece that amount approximately to 60% of the total Greek population insured. Currently, according to Dr Elefteriadis, a senior IKA's medical consultant, there is a national law under discussion to further merge all the insurance funds into one. Nonetheless, the core of the Greek NHS remains the general hospital as analysed in chapter nine. This study examines the structure of the NHS assuming that by 2011 there is going to be a central insurance framework for all Greek nationals. All Greek citizens have free access to healthcare. 60% of hospital care is offered mainly by public hospitals. Based on a fee-for-patient service catalogue, social polyclinics or hospitals receive social security reimbursement. Private hospitals are covered mainly by private insurance. Public funds have a modest public insurance contribution to the fees of a private hospitalisation.

2.5.2 America

In North America, as in Europe, the confusing governmental policies, the emergence of new technological applications and the evolving needs of the consumers and health workers create a new dynamic environment. In Canada, the need for a patient-oriented focus on services is in accord with global needs to blend skills with ideas, policies and strategies. Quality in Canadian healthcare institutions is a continuous effort to ensure patient satisfaction. From the start, the qualitative standards have operated in an exclusive environment. Key features, similar to the situation in this study, define this environment, where healthcare providers establish standards through a consensus process. A fundamental part of delivering proper medical care is the correct diagnosis. Systems developers and healthcare stakeholders will need to redesign documentation workflow of EHRs, and policymakers will need to adopt a more rational approach. Thus, providing access to information, record sharing, maintaining tracking history, tracking tests, are some of the objectives that have to be considered in such a framework redesign (Schiff and Bates, 2010). In a consumer-centric environment, all information standards should be available, and, thus, what is common quality practice will create a benchmark for public trust (www.ccareonline.com). Figure 2.15 exhibits the evolutionary stages in regard to consumer-centric principles and correlates them with the exclusivity of the participation factors.

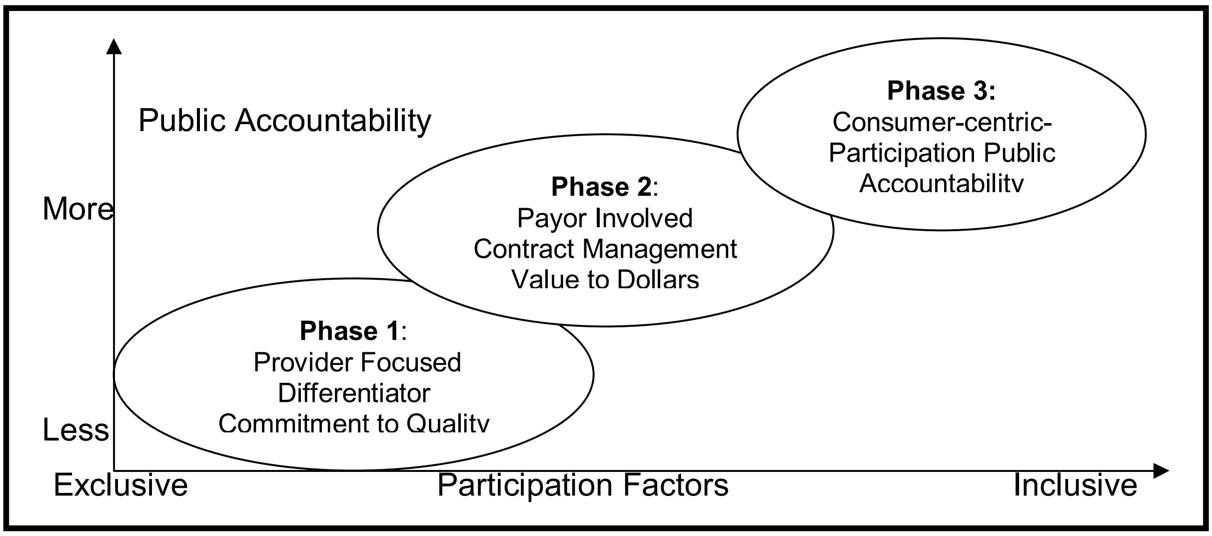


Figure 2.15: Consumer Centric Evolutionary Principles (Stavert and Boon, 2003)

In the USA, there are many hospitals that are focusing on patient-oriented principles. Many hospitals across the US, with similar efforts, are now focusing on patient satisfaction (Kirby, 2005). The “Patient Profile Study” is a distinguished study that is relevant to the patient-oriented philosophy, but it aims to accurately capture service-need and use in clinical decision-making. It is a continuous evaluation system in promoting improvements in a large mental health treatment system. The effort of this study, as with all the others examined, was to promote patient-profile records for continuous evaluation. Such records being incorporated into database future administrations keep track of their patients through a standard patient-treatment review process that takes place every six months. This type of studies is constantly being undertaken in an effort to cope with the dynamic nature of the global healthcare industry. The Institute for Medicine (IOM) clearly defines the rules of quality healthcare in a three-part series of reports. The IOM, first report issued, defines the quality as “the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge” (Institute of Medicine Report, 2001).

Primary healthcare research on patient-satisfaction measures showed that GP referrals, a significant cost coefficient of the total healthcare cost incurred per patient, should be closely monitored for several reasons. Psychological scales on anxiety from uncertainty, risk, fear of malpractice, autonomous and controlled motivation malpractices are directly relevant to unnecessary referrals adding unnecessary cost to a patient-oriented healthcare system. Thus, qualitative analysis behind unnecessary referrals adds value to the patient flow at minimal cost (Franks et al., 2001). Another in a recent research study, at Sun Health Del E. Webb Hospital, emergency department clinicians redesigned their care processes to accommodate rapid growth in patient volume. To decrease patient waiting triage nurses’ assessment has been replaced by a "quick-look" personnel tech that checks patients' vital signs and then sends them to a treatment area, where an immediate assessment is performed by a physician and nurse (Vanca, 2007).

The major objective behind all these efforts is quality frameworks with simple structures, measurable low care-cost transactions partly by controlling not only physician referrals to specialists but the patient flow at every level possible. In the USA, however, it seems that these efforts to control low cost oriented transactions, analysed in this section, may have adverse consequences for health outcomes and patient satisfaction if not measured within a specific strategic national framework.

2.5.3 Asia

Japan has enjoyed a high-quality medical system for the past 30 years. Japan has the highest life expectancy, not only in Asia, but also in the world. The WHO ranked the Japanese medical insurance system number one worldwide in the year 2000. Japan also ranks number two for total medical expenditure and number seven for per capita medical expenditure (Takeshita, 2005). A patient-oriented healthcare system involves the patient condition decision-making, a field where Japan is lagging behind. Although most of the publicly-insured patients hold a personal patient card in order to enter the Japanese healthcare system, a study showed that 80% of patients want to be informed about their medical records. Information related to physician and hospital performance should be disclosed, although such patient-oriented services are not currently available.

Although the Japanese healthcare system differs from the Chinese, as it is ranked among the highest performing countries in the world, these two countries have co-operated in many industries for many years. China's model is a "public contract model". The whole population is covered by different types of modest public insurance, although almost 80% of the country's hospitals are privately-owned (Hyoung-Sun and Hurst, 2001). On the other hand, China is an Asian country striving to enhance the quality of core healthcare services and strengthen technical competencies and infrastructure, in order to improve competitiveness as it is ranked according to WHO (2003) in the 144th place among 191countries. China today is trying to improve patient satisfaction by offering quality medical services and requirements (Huang, 2002).

Israel is a Middle East example of a pioneer in the contemporary concept and practice of public health and, as a result, has one of the world's healthiest populations. The country's success in pursuing effective public health policies is reflected in the fact that a nation of immigrants, who arrived principally from North Africa, the former Soviet Union and Central Europe, has one of the highest average life expectancies in the world (Griver, 2005). In conclusion, it is obvious that in Asia there is also an increasing interest in patient-oriented national frameworks.

2.5.4 Australasia

Quality improvement is an important issue in the healthcare system in Australia. The Commonwealth and South Australian governments are committed to the development and implementation of quality improvement and enhancement practices that reward or promote high standards in the delivery of public hospital services (Australian Healthcare Agreement) (Hordacre et al., 2004). The South Australian Hospitals Safety and Quality Council were formed to oversee the process and review progress with regard to the achievement of state and national priorities. In 2001, the South Australian Hospitals Safety and Quality Council introduced the Evaluation of Hospital Services (PEHS) to identify key dimensions of care and to measure patient-satisfaction within these areas. Structured questionnaires have been given every year since then to patients, including demographic and economic parameters and their satisfaction (Hordacre and Taylor, 2003-2004). In the past decade, however, there have been four different restructurings of the Australian health sector (Van Eyk et al., 2001).

Based on such experiences, in 2002, the New Zealand Magnet Advisory Network was established. The Magnet network was initially a group of professional nursing leaders working collaboratively to support and shape the introduction of magnet principles in New Zealand. In 2003, the group reformed to become a more inclusive Magnet NZ. The core group includes representatives from nursing and other health professional groups, district health boards, and other health provider organisations. It provided a framework to recognise excellence in management philosophy, the quality of patient care and attention to the cultural and ethnic diversity of patients (www.

moh.govt.nz). In conclusion, it is obvious that, in Australasia as well, there is also an increasing interest in patient quality for national healthcare frameworks.

2.5.5 Africa

South Africa is considered to be one of the pioneer countries on the continent in the healthcare sector. The first democratic government elected in South Africa in 1994 inherited huge inequalities in health status and health provision across all sections of the population. Patient-satisfaction with healthcare providers in South Africa has mostly been studied in relation to race and socio-economic status. A 1998 countrywide survey of 3820 households assessed many parameters of healthcare delivery, such as levels of satisfaction with healthcare providers among different segments of the South African society. Almost 51 percent of the respondents had attended a primary care facility in the year preceding the interview and were retained in the analysis. After adjusting for gender, age, and type of facility visited, both race and socio-economic status were significant predictors of levels of satisfaction with the services of the healthcare providers (Myburgh et al., 2005). Most South African researchers conclude that there are great inconsistencies in quality relevant to demographic parameters and geographic locations of the country. As a result, any assessment of equity-driven health policy in South Africa should consider the impact of both race and socio-economic status on client satisfaction as one of the indicators of success.

In conclusion, in this section it has been shown that there is global evidence in regard to the development of strategic frameworks that include patient-satisfaction issues. Given the above geographical limitations, this section has placed in perspective qualitative standards relating to patient satisfaction, relating achievement to the particular attributes of the individual country.

In addition to all the above national healthcare frameworks and parameters presented, there are certain common issues that have to be discussed. It is a common practice throughout this section's review for well-functioning health systems to guarantee that all citizens should have access to affordable health coverage (www.acponline.org/hpp/afford_7years.pdf on 6 November 2007).

Thus, it is a common belief among OECD counties that a measurable patient-oriented flow framework based on innovating healthcare-structure models can provide high-quality care. The following section will focus on major international patient-oriented practices and principles in an effort to further analyse the patient-oriented perceptions encompassed in such practices.

2.6 Critical Review of Major International Patient-oriented Flow Initiatives

The two major initiatives that are considered are patient-oriented frameworks focusing on healthcare processes and especially the patient flow. Based on the patient-oriented models and information systems they are considered for evaluation as other patient-oriented frameworks. These initiatives are carried out primarily in OECD countries. For the internal and external environment performance system evaluation, a series of balanced scorecards encompassing critical characteristics and measures for evaluation will be used. Lead measures should be considered for assisting in the information quality of the model's supporting system. The nature of these measures is important as the model's structure aligns with the information systems philosophy of measures (Anderson and Mc Adam 2004). To conclude, in order to compare these major patient-oriented initiatives a brief description and examination of the table 2.3 critical characteristics must be implemented.

CRITERIA	DEFINITION
External and Internal Environment Competence	The evaluation criteria for processes adaptability to the organisational strategy
Information Technology Competence	The necessary information technology required for study implementation
Infrastructure	The necessary requirements that have to be present for study implementation
Study Benefits	The actual pilot study's benefits
Government Funding	If there is any government funding for process implementation

Table 2.3: Study Criteria

According to this research study, it is obvious that there is a certain plethora of patient-oriented frameworks issues that have to be addressed. Although most of the systems address such issues relevant to organisational processes, little work has been done for models and their supporting information systems interrelationship (Neely, 1999; Bititci et al., 2000). The performance evaluation principles of a flow structure could provide critical interrelationships among the system's actors, acts and results. These interrelationships could produce a novel measurable patient-oriented framework. At this point, there is a need for a definition of traditional and lead benchmarking. Traditional benchmarking measures encourage short-term results and lack organisational strategy as they are not planning long-term and lack external environment focus. They are considered as lag indicators (Kaplan and Norton, 1992). On the other hand, lead measures are predictive measures that go beyond the internal and external environment, financial or not financial, in an effort to drive future, anticipated frameworks' results. Value-added concepts need such measures, as there is a shift from tangible to intangible assets management (Barsky and Bremser, 1999).

The next parameter refers to the framework design competence. Each performance measurement included in the supporting information system should have a specific interrelation with the ontological model in order to produce a patient-oriented framework. This necessary infrastructure, according to PATH study is subject to the degree of utilisation of the necessary resources used (Keegan et al., 1989). In any case, all resources, tangible and intangible, will be subject to results produced from this study's ontological framework. Study benefits are considered any transactions results that could add value towards the implementation of a new, cohesive, measurable patient-oriented framework. Enterprise ontology based on Habermas's Language Action Perspective (LAP) is potentially able to bridge benchmarking gaps by providing common understanding among people of different cultures (Berners-Lee et al., 2001). Finally, the table's 2.4 key dimensions that are used as criteria for reviewing patient-oriented, study benefits presented in this section has to be supplemented by the relevant framework prerequisites set for this review which are primarily based on the value-added supply chain basic methodology (Dell and Freedman, 1999).

Framework Information Flow	This criterion examines if the information flow is possible with the proposed technology.
Information System Prerequisites	Requires information systems harmonisation with other model's technological profile
Concept Compliance	This criterion examines if the system fits the framework's concept.
Reengineering Support	Determine if new processes could be supported from the information system
Model Customisation Opportunities	If the model could adapt to change or will it become obsolete

Table 2.4: Framework Design Competence Criteria

The first international study implementation under study is the Performance Assessment Tool for Hospitals known as the PATH study and is introduced next by WHO. The second large international implementation under study is a UK study. This UK study is the Quality Indicator Study known as (UK QIP).

2.6.1 Patient Assessment Tool for Hospital Quality Improvement (PATH)

The European office of the World Health Organisation (WHO) initiated a tool for assessing hospital performance called PATH in 2003. This study aims for an evidence–based, healthcare organisations redesigning and process improvement based on this tool. More than 100 healthcare performance indicators were analysed in 20 European Countries. The results exhibited in this study were six dimensions that are essential for assessing hospital performance. The empirical findings of the 11 countries' respondents exhibited that the PATH network is Anglo-Saxon in orientation, as most of the indicators express such a philosophy. Greece has no participation in this study. The path framework underscores the internal use of the set of the indicators as "neither the dynamics nor the dynamics of improvement (through quality measurement) work reliably today… the barriers are not just in the lack of capacity among the organisations and individuals acting on both pathways" (Berwick et al., 2003).

This study is directly relevant to the criteria set for this study, as this study's criteria are the set according to the World Health Organisation's standards and measures. This study is the largest regional effort in the European Community relevant to the study's theme. The characteristics and parameters below for performance measurement system critical review were proposed by WHR (WHO, 2000). The organisation assumes that efficiency is synonymous with performance. Thus, this list of characteristics and parameters of measures takes into consideration all inputs in order to generate outputs. The following criteria table is based on these key dimensions of hospital performance measurements criteria introduced by WHO.

Responsive Governance	The degree of interrelation between transactional measures and organisational conceptualisation governing a healthcare institution
Staff Orientation	Staff policies towards patients
Patient Centeredness	All patients should receive proper responsiveness assuming the proper confidentiality
Safety	Critical characteristic for all clinical practices
Clinical Effectiveness	Performance Measurement Parameter (individual and population)
Production Efficiency	Performance Measurement Parameter

Table 2.5: PATH Study Criteria

Interrelationships among different measures define the organisational strategy, where there is a little research reported. Ultimately, the healthcare statistics of the developed countries could form a picture of the social structure of their society (Rosenthal, 2007). That is what is defined in the relevant table as responsive governance (WHO, 2003). Measurement coherence with the organisational strategy is a necessity for a responsive and well-defined patient-oriented performance framework.

Compatibility between internal and external environmental parameters is also important. To deal with the dynamic external complex environment that is inherent in social systems it is necessary to understand the parameters of compatibility. The performance perspective measures require the necessary information flow capabilities for the processes' implementation to define the exact sequence of activities involved in the processes under evaluation (Lebas, 1995). The performance perspective measurement factor is directly relevant to the information technology factor. Based on parameters set in table 2.4, the necessary technology for the operational systems is set as a requirement in order to operate a performance measurement system successfully. The technologies proposed in this study are actually the standard ones that each hospital has. It is imperative for the success of the study that technology standards are set accordingly to the average participant members of the WHO regional office. Thus, the technology proposed is the standard Electronic Data Interchange (EDI) for the purpose of benchmarking practices. Most of the organisations are today considering the common standards of EDI technology. The use of the common EDI technology standards is the necessary and proper infrastructure for the application of the measurements. There is, however, a gap in evaluating the results of such a framework's infrastructure. Benchmarking practices are governed by many different approaches, mostly cultural and geographical in this study. The structure of the benchmarking process is developed, most often, by a step-by-step process model that underlines a common language within organisational models (Spendolini, 1992). A number of process models for benchmarking have been proposed by various authors. The more recent include process models that are generically derived from literature based within existing theory. Therefore, recent models, as the one that is proposed in this study, are limited in relation to benchmarking implementation within the contemporary unsettled environment (Spendolini, 1992; Watson, 1993). Although there is a lack of benchmarking referrals in this study, as this topic is outside the aim of this study, benchmarking is nonetheless a valuable criterion for evaluating the transactional result performance of the model of this study. The benefits of this study are obvious. First of all, and for the first time 20 countries and so many experts have participated in a common effort to produce a common set of measurements for healthcare. A flexible and comprehensive framework of measures that could adapt to the different national healthcare systems in an effort to asses healthcare organisational performance is a great effort for the European region. Hospital processes are directly linked to their performance measures, which are complex and multidimensional. Based on European healthcare evidence, for the first time this study introduces two sets of indicators for use in European hospitals.

Practicality and measurability are major study benefits, if applied, as they could be used as thresholds for evaluating healthcare frameworks. Practicality and measurability are necessary to evaluate the model's and the system's effectiveness and efficiency. Thus practicality provides organisational effectiveness that could encompass dimensions like value-added service, patient satisfaction, healthcare quality similar to customer satisfaction, and product quality (Anderson and McAdam, 2004).

Organisational effectiveness is another core performance measurement parameter to be considered for successful healthcare frameworks. According to Professor Drucker the measurement dilemma is ever-increasing, as a traditional measure is not adequate for business evaluation (Drucker, 1993). Internal resource efficiency is the last benefit, if applied. In a hospital environment, efficiency measures the degree that all resources are being used for the patient treatment and satisfaction. Other tangible assets that depreciate through time, have to be measured based on their contribution to organisational production as well (Fitzgerald et al., 1991). The actual PATH benefit is not only the interest of the different healthcare organisations to improve their performance standards but also the momentum on setting national and international benchmarking networks (Kazandjian, 2003).

Government funding is absent from such a large scale multinational study with potential measurable results. In Greece, various government-funded studies are limited to assessments for financial measures like the cost efficiency of general hospitals, focusing on Structural Equation Models (SEM) like Data Envelopment Analysis (DEA) and Confirmatory Factor Analysis (CFA), and have shown that the efficiency of 98 out of 126 public hospitals of the Greek national health system is directly relevant to the degree of utilisation of tangible and intangible resources as well as the production efficiency of the general hospitals researched (Athanassopoulos and Gounaris, 2001).

2.6.2 The UK Quality Indicator Study (UK QIP)

The UK QIP together with the USA QIP is the largest international data set of quality indicators. In 1988, this study initiated in the USA received funding from the Robert Wood Johnson Foundation and now includes 49 hospitals. In 1989, the UK government published its White Paper on NHS reforms titled “Working for Patients” emphasising patient quality. The result was the UK QIP that began as a study in the NHS public sector in 1991. The UK was the first country in Europe that initiated such an effort. The private sector participated more actively than the public sector in this effort and contributed towards the creation of lead indicators that are considered patient-oriented. Almost half of these indicators created concern patients’ quality attributes and almost all of them consider the patient as the major coefficient for their performance assessment framework development. Today 143 UK private hospitals are enrolled on this study and include almost two-thirds (Thomson et al., 2004).

One of the most practiced assessment performance systems, the star rating system, was initiated from the efforts of the UK QIP study. Once these indicators were publicly available, they formed a core part of the NHS performance management, and they were included in the star system, which itself assisted in considerable benefits of the effective use of such indicators. There is a direct link between the medical organisations with the NHS environment as of 2002 that this study completed in the UK. This link is enforced by the study standard A3.4 enforced by the National Care Standards Committee (NCSC). According to this standard, all medical practitioners provide the registered person with, and make available to the National Care Standards Commission, critical clinical and performance indicators about any patients treated. The creation of a statutory body enforces the tight correlation between the external and internal environment, as it oversees national minimum standards (Department of Health UK, 2000). There is no reference to certain consistent, information supporting system standards across the healthcare sector for enforcing such patient quality indicators. As there is still a lack of proper expertise to guarantee the necessary information quality requested for this study in order to develop a healthcare industry standard, the UK QIP study strives to maintain itself as the sole provider of such technology infrastructure. In this way, paradoxically, an industry-wide standard is feasible (National Care Standards Commission UK, 2002).

The QIP is based on the collection, collaboration and quarterly comparative reporting of the success relevant to the system's common communication. The benefits of this study are many and relevant to patient-oriented practices. It is obvious that the understanding of quality healthcare indicators varies across the healthcare sector. Due to the QIP international and the nature of the study as well as academic institutional affiliation required, the integrity of the study is unimpeachable. There is also no direct government funding for this study. In a way, however, there is in effect "indirect' funding. Thus, patient-oriented systems started to flourish based on the international and the UK QIP study initiative (Thomson et al., 2004). Finally, this study assists to further comprehension and comparison of healthcare organisational performance. It also reconfirms this chapter's evidence that the patient orientation is geographically and culturally different and thus different indicators are practiced in different countries, although the concept behind patient orientation remains the same.

2.7 The Need for a New System

The focus of this chapter's literature review is the redesign and measurement, based on different applied methods, of a healthcare flow similar to that of Greece. The national or even international dimension of this study underscores the necessity of a common structural and informational organisational design necessary for further development towards patient-oriented frameworks. All of them have indicators that are considered based on this study's definition relevant to the concept of patient-oriented flow. Their basic redesign proposals were primarily made based on:

1. Measurable quality information relevant to patient flow from the healthcare perspective and secondarily from the patient perspective.
2. Such redesign approaches produce processes and transactions that are mostly cost-driven rather than treatment-driven.
3. These studies under consideration underscore the lack of healthcare models and information systems design based on patient needs.
4. The methodology of their reengineering has no scientific background as the methodology followed is rather practical.

Enterprise ontology and the DEMO methodology for organisations bridge this need for common measurable and scientific reengineering. There is a great need for such an object system or framework, as these patient-oriented flow framework objectives should focus on:

1. The model's transactions and acts as well as their information supporting system which results in patient treatment and satisfaction.
2. The supporting, information system balanced scorecard method could assist in the cost reduction of many internal processes.
3. The information system designed on CLIPS for the implementation of this framework should measure a healthcare flow model that is aligned with this framework's concept.
4. The supporting information system uses interactive reporting of measures that dynamically evaluate the model's performance.
5. This novel healthcare framework could represent the country's concept towards patient flow.

On the other hand, certain prerequisites and obstacles for the implementation of the above objectives should be considered. First is the obstacle of international structural cohesiveness. Many countries perceive certain indicators differently, due to their healthcare system structure (Spendolini, 1992). Another obstacle is benchmarking at international level. It is an obstacle that is outside the domain of this study, although it could be solved through the development and parameterisation of the proposed novel system's approach. It is also evident that interoperability issues should be attained both internally and externally at a certain level. Thus, the minimum of the EDI standard is a need for all healthcare systems. Once the information systems are interoperable then the model's processes could be effective and corrective (Lebas, 1995). It is a fact, however, that the UK National Service Framework (NSF) set information goals to enable best NHS strategy. It is also true that the UK national implementation strategy for effective and efficient management is summarised in the figure 2.16:

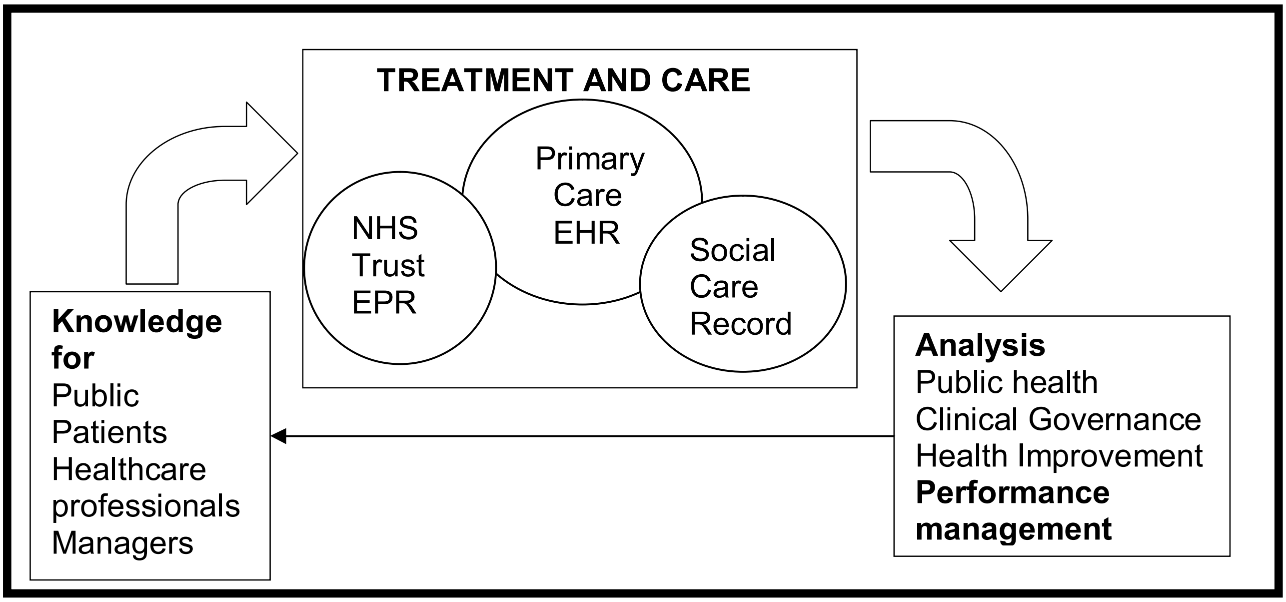


Figure 2.16: The UK National Strategy Framework (1998-2005)

To ensure the quality in information required, according to the figure 2.16, as well as the necessary organisational model processes and procedures, managers and researchers should follow the UK national service framework and support this effort by devoting considerable resources in order to improve patient satisfaction and treatment.

A novel, measurable structured framework of processes must then be considered given the external environment of the country and the internal environment of the healthcare system in order to improve the health of the population based on DEMO methodology. The measures introduced also vary in their hierarchy and weight as well as their thresholds. Most of the studies analysed in this chapter attempt to change from healthcare- to patient-focused assessment, and thus they face a series of obstacles that have to be overcome. These identical healthcare performance issues, as the above studies indicate, are delivered differently at the national level. Ultimately, the most important need for a new ontology-based patient-oriented flow measurement system is the scientific methodology needed for the creation of such a system. It is obvious from the above studies that there is a lack of common scientific methodology practised partly due to the differences of the national healthcare frameworks of each country. The studies analysed denote a serious need for a common conceptual, coherent, comprehensive and concise model in order for each nation or healthcare organisation to build their national strategies on common ground. This novel framework will include a model that is called an ontological model which will provide the necessary foundations for a common scientific methodology which will leave, at global level, no space for misleading measurements (Dietz, 2003). Then, this novel framework supporting the information system implemented with CLIPS technology will assist the research community towards a common understanding, as ontology provides a number of useful features for intelligent systems as well as a common understanding for measurable knowledge representation (McGuiness, 2002). Specifically, ontology will solve cross-cultural issues relevant to healthcare performance evaluation, interpretation and analysis based on its philosophical roots described by Husserl as *characteristica universalis* (Poli, 2003). The patient-oriented, framework redesign proposed should be able to answer at least these questions:

- Will the patient receive satisfactory treatment over these multiple structural transactions with the healthcare system?
- Does the supporting information system empower the patient to make a decision of at least one alternative path flow choice?

This ontological model redesign will include the necessary patient needs and its possesses' measurements through an interactive reporting system that will deliver valuable evidence regarding a patient-oriented, healthcare flow design that will adapt to national healthcare strategies of each country. A novel approach of a patient-oriented system would have to focus on the life-long relationship between patient and healthcare providers and measure its results based on treatment and satisfaction measures indicating the overall cost of this relationship. This means that the patient flow process, which has to be a treatment process, will not be measured per incident only but as a part of the whole healing circle of any patient condition type that will enter the ontological structure of this flow. The patient as an active entity will have access to proper data, like the POMR supporting information system proposed in the next chapter, to comprehend the flow process of his/her case. The sum of all the healthcare processes and transactions that will lead to treatment (effectiveness) and also to a competitive cost of that treatment (efficiency) will provide valuable knowledge and will set a new, accessible level for measuring and possibly restructuring the patient flow on a national or even international level in a scientific way. Such a framework could assist in an accessible and competitive healthcare environment with effective and efficient redesign of patient flow. It will thus eventually minimise the cost of the care treatment life circle (efficiency).

The patient-oriented healthcare framework proposed at primary transaction level should be designed to meet the everyday patient’s needs. It must also have the capability to respond to individual patient’s medical condition and personal choices. In order to truly customise patient condition needs and values a dynamic set of measurements should be in place as a necessary decision tool for core transactions of the ontological patient-oriented flow. Also, at secondary and tertiary transaction level, as described in the next chapter of this study, downstream transactions and specific acts will be also measured to add value providing high patient satisfaction measurements to the primary ones. The downstream transactions and acts are those relative to patient services. Core, reengineered, downstream transactions will be picked from the patient flow as performance cells to be measured based on DEMO methodology.

The framework proposed, defined from now on as an object system (OS) due to the Dietz (2003) redesign methodology presented in the next chapter, will treat the patient flow process at all levels as a cross-functional process, which will include four sub-processes. The sub processes will clearly define the proactive patient treatment, the actual patient inflow and outflow treatment. The need for these sub processes is to clearly organise the patient-flow domain by patient value-added service at each healthcare level rather than by healthcare function. Focusing on patient value-added services assures the flexibility necessary for process improvement, as presented in this chapter's literature review. The basic, information infrastructure interoperability or a hybrid system allows either integration or interoperability depending on the information data sets or subsets required for decision-making or sharing on each act at least at the primary and secondary transaction level. The supporting information system (POMRS) should be a module that is fully embedded within the ontological OS. Thus, based on systems interoperability, the ontological framework produced should include, besides the patient flow model, a supporting information system. Figure 2.17 exhibits how the ontological framework produced should encompass the necessary information system, its infrastructure and organisational model for the implementation of a patient-oriented flow concept:

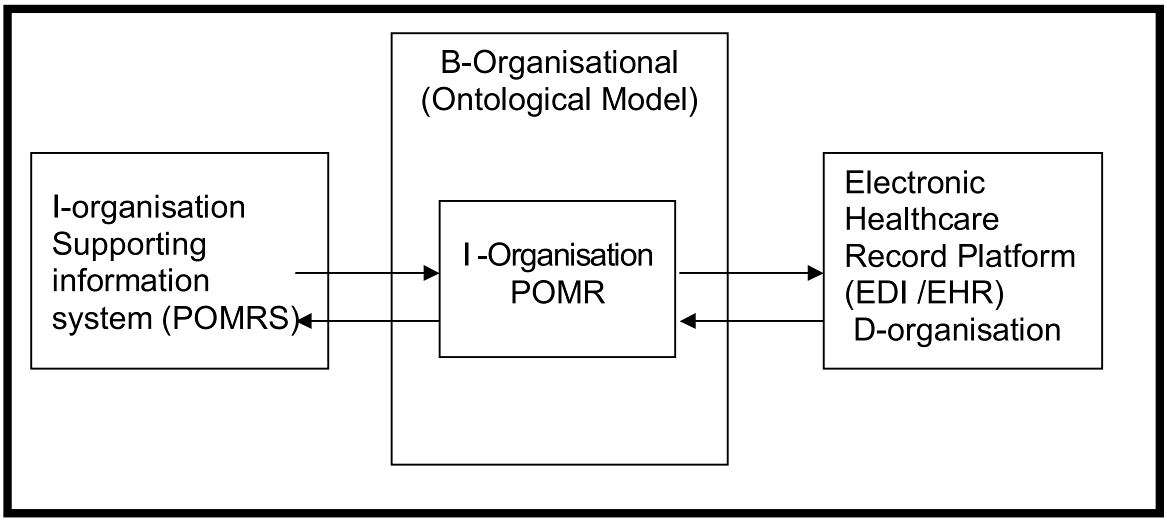


Figure 2.17: Basic Information infrastructure for a Patient-oriented Management System

The novelties described below assume that the external environment (NHS) could deliver the necessary information at the info-logical level required to implement this patient-oriented design. In the next chapter, the organisational theorem of enterprise ontology will introduce the relationship among ontological (always coloured in red), info-logical (always coloured in green) and data-logical (always coloured in blue), levels of this OS. Most healthcare institutions in the developed countries are lacking the necessary information infrastructure to implement at least the minimum integration with electronic patient records that is a major coefficient of this model. In any case, the concept that reflects the healthcare strategy of the supporting information system which provides valuable measurable knowledge to the healthcare community is the following:

- Vision: Healthier nations
- Mission: Proactive, available, at all times and levels healthcare
- Objectives:
    a. An interoperable information sharing quality system;
    b. Evidence based treatment in accordance with the patient's treatment circle;
    c. Efficient (satisfaction) and Effective (treatment) healthcare delivery measured based on treatment life circle versus the total cost incurred;
    d. Leading minimum measurements for national benchmarking practices;
    e. National standards for performance that lead to measures usage for accreditation based clinical governance audits.

Finally, figure 2.18 presents the big picture of the necessary model transactions and its supporting information flow required to implement a successful patient-oriented framework. Taking into consideration Wolstenholme's patient flow process (Wolstenholme, 1999), as well as from the current processes from several healthcare institutions in Northern Greece exhibited in this chapter's literature review, figure 2.18 exhibits the big picture of the proposed patient-oriented flow process.

To ensure such quality parameters, these six core transactions, which are exhibited in this figure, will be introduced in the DEMO methodology (Dietz and Borjis, 1999). Thus, a novel, measurable, ontologically structured framework could be produced. In chapter 6 this analysis will be further parameterised to enterprise ontology at ontological, info-logical and data-logical level. (Papagiannis et al., 2005

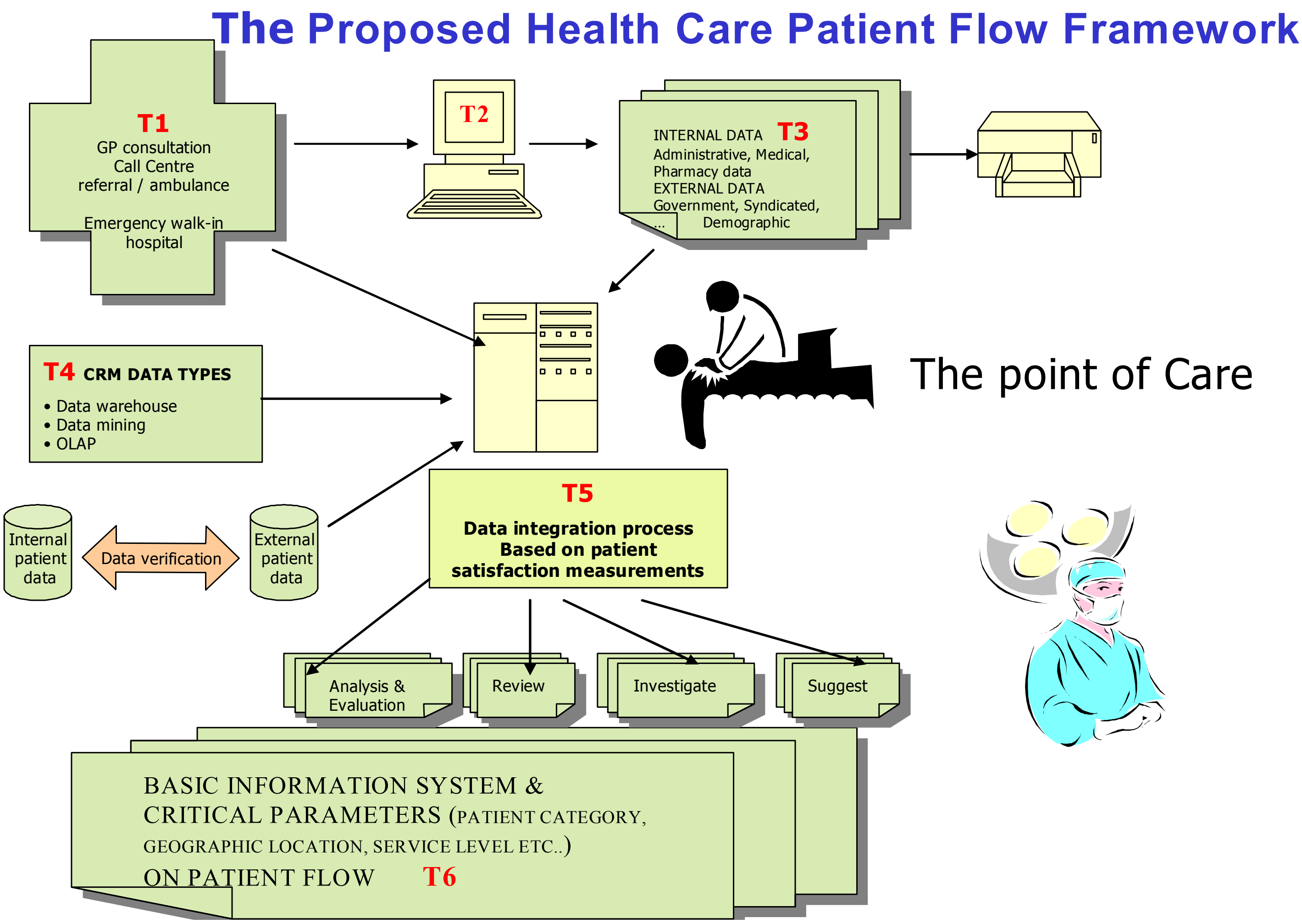


Figure 2.18: The Proposed Healthcare Patient Flow Framework

A patient with a chronic cardiac complaint enters the healthcare system with inflow transaction (T1) should get a referral from the GP through a national call centre (1535) based on performance measurements that general hospitals should follow at national level. For this patient condition, the GP should be able to receive data based on EPR analysis transaction (T2) and match it with the general hospitals that have, ideally, NHS compatibility based on a patient-oriented supporting information system. Such an option could result in preparation of a safe treatment (T4). Thus, the GP's decision is communicated with an informed patient giving the line of reasoning behind the GP's proposal for successful hospital discharge (T5) and rehabilitation monitoring (T6). Then, the general hospital's clinic according to this figure will have to be organised per patient condition based on the patient-oriented measurements both internal and external. The data integration process is the measurements scorecards analysis, reporting and evaluation of the treatment received from the general hospital's cardiac clinic much like an SBU described in the literature review. This proposed patient flow framework concept, if the right measurements from the supporting information system are provided according to this study's ontological model, will contribute to a healthier nation with the patient exiting the system (T6) treated with proactive healthcare along the treatment circle of the patient flow. Thus, external competition at all levels starting from the GP's referral will encourage patient flow redesign initially at secondary level (general hospital internal environment) focusing on patient parameters over the period of the disease time based on a quality data flow.

Another novelty of the system is that the different healthcare organisations are analysed as an integrated healthcare organisation that is able to receive patients at GP level until they are fully rehabilitated and their transactions results are selectively disclosed to patients entering the flow. As a result, a healthier nation with competition focused on treatment and patient satisfaction over the treatment life circle will raise the minimum performance requirements of healthcare performance especially for chronic diseases. Simultaneously, another effect will occur: that of lower hospitalisation costs due to competition. Such a patient-flow structure together with the novel, supporting information system will also enable patients and healthcare providers to have real cost figures over the treatment circle of a disease rather than cost per visit. This approach will encourage long-term planning and strategic initiatives and add knowledge for the entire system's stakeholders and especially the patients.

2.8 Summary

A series of efforts regarding patient-oriented healthcare both on the national and international level underscores the ongoing need for qualitative healthcare. The consumer-oriented as well as the patient-oriented approaches around the world reviewed in this chapter highlight a series of different healthcare approaches regarding patient-oriented concepts. Most of these different approaches are related to cultural as well as to structural differences at national level. The studies analysed lack common understanding, described by Husserl's as characteristica universalis, of issues relevant to healthcare design, evaluation, interpretation and analysis.

Although based on the HOCAPRIT foundations for reengineering, enterprise ontology is the scientific tool that could provide patient initiated activities included according to enterprise ontology in the relevant processes and transactions. Thus, ontology provides a novel framework tool, based on the WB model of the DEMO methodology, for healthcare organisational infrastructure, which consists of a series of acts, transactions and processes. These acts and transactions will be measured based on the BB model of the same methodology in order to provide evaluation standards from each country's national structure framework. Such a redesign is sensitive to both the internal and external environment due to the methodology's hierarchical nature based on the action transaction diagram and ontological parallelogram analysed in chapter nine of this study. Enterprise ontology will also be used to bridge this cultural and structural gap among countries. The leading measures introduced in the next chapter based on the BB model's supporting information system will receive input from the ontological model and will provide output based on the efficiency and effectiveness of each core transaction. The sum of all transactions' measurements will provide an integrated, weighted average that will signify the degree of patient orientation of each patient flow through the different healthcare organisations in accordance with the national healthcare strategic framework.

The results produced may possibly provide satisfactory and cost-efficient treatment through the delivery of acceptable patient conditions through the healthcare system. It is also a fact that such an ontological framework will leave no space for misinterpretations irrespective of their origin. It will also provide a flexible and scientific methodology for evaluating and possibly further redesigning the healthcare orientation at national or even international level. The next chapter will introduce the research methodology adopted for the aim of this study.

Chapter 3 Research Methodology

3.1 Introduction

The previous chapter analyses the background of the research problem and presents the aims and the objectives of this study. This chapter presents the outline of the research methodology that will be applied in this study. The clear definition of the research problem as well as the research question is also presented. Research is any organized inquiry carried out to provide information for solving a problem (O'Salivian and Rassel, 1989). A research methodology is viewed as a system of methods. This study considers the satisfaction levels that a patient in Greece receives from the healthcare industry. To obtain a synopsis of the prevailing situation, it was decided to design the questionnaires to provide results of the satisfaction levels both in public and private general hospitals in the area of Northern Greece. The methodology that was followed to construct the questionnaires as well as the statistical analysis methods used are presented below.

3.2 Research Problem and Question

As highlighted in the previous chapter, the escalating healthcare costs together with the efficiency of the industry in providing effective patient care have received the attention of the European governments and their communities. Effective and efficient patient flow requires a great deal of attention for its improvement. Efficiency and effectiveness are mainly focused on a performance framework primarily on the secondary patient-care and specifically the general hospitals. It has been identified that the inefficient patient flow of information and measures is a major cause of this problem (Bates and Gawand, 2003). Other studies suggest solutions for the cost and medical error reduction based on clinical support, decision systems that use the Electronic Patient Record (EPR).

In Greece, in an effort to reduce medical costs, general practitioners as well as other medical staff have their offices within the hospital's facilities. Private GP offices are also in existence outside the hospital premises.

It is difficult to physically separate the organisational limits between primary and secondary healthcare in Greece. Most patients at public primary level, as of 2010, however, visit doctors with an appointment system set by the general hospital in a government effort to minimise medical costs within the public hospitals' facilities. It currently takes a great deal of time to set an appointment with a general practitioner or certain medical staff, although the costs of the visit are fully covered by the public insurance. The GP's appointment hours within the hospital premises are usually evening hours. In this way, the government saves money from the national operating budget and doctors, especially young ones, could provide their services to a large clientele, as the system from 2007 is very popular in Greece. As more and more patients are visiting the GP offices within the hospital premises, their responses to primary-research questions regarding secondary healthcare level includes patients' perception of the Greek primary healthcare level as well. Thus, the core of this national patient-oriented flow has to be the hospital that also includes primary services as well.

A major issue of this study is to further improve, by measurable means, the patient satisfaction, care and treatment record at any healthcare level, especially primary and secondary. The focus of the research concerning this study is to gain new knowledge and understanding of the patient flow taking into consideration critical success factors based on the national, external healthcare environment for the patient experience that could be measured and evaluated.

The research problem is defined as: "The contemporary lack of patient-oriented external parameters and internal transactions that guide and measure the quality service of the patient flow primarily within the healthcare premises that currently leads to lack of patient satisfaction, treatment and high hospitalisation costs."

The solution to the problem concerns an intervention in the problematic areas of the patient flow process as far as patient value-added is concerned, based on a proposed OS or rather framework. The term OS and framework might be considered for the purpose of this study almost identical to the degree that framework is considered as a re-usable measurable design for this study's OS. Systems analysis and design methods must be included to identify the problems of the current situation and define how a new object system or framework could redesign this flow accordingly. For the purpose of the system development and implementation, the necessary methods and tools will be implemented. Such implementation will lead to system evaluation and control. Information science as well as management science provides concepts, tools and methods that have already been applied successfully in commercial industrial practices. For the purpose of this study, it is essential to consider such practices and tools and their implementation within the healthcare industry. The Designing and Engineering Methodology for Organisations (DEMO) introduced for the development of this framework is based on the enterprise ontology and has currently been being applied for the last 15 years for several organisational practices.

Based on the literature review, the healthcare industry lacks initiatives towards the adoption of such performance systems, specifically patient-oriented concepts and Patient Relationship Management (PRM) tools. It is, therefore, important to provide answers to the research question that asks, "How could management science and the information science tools and methods contribute to the design and implementation of a patient-oriented flow process solving the problem of low levels of the patient quality value-added currently in existence". This is the description of the research question that, with the introduction of the ontological principles based on the enterprise ontology, will lead this study to the next level.

3.3 Research Approach

The aim of the research approach which is presented and analysed in this section is to provide a clear picture of the researcher's steps and procedures applied in the multidisciplinary field of this study that resulted to the framework proposed (OS) and its results.

3.3.1 Research Methodology Steps and Procedures

Major research methodology steps and procedures of this study are the following:

1. Initial review to capture research problem :rapid information collection

Initially the research was implemented with rapid information collection to gain an understanding of the various disciplines that relate to the purpose of this study. The initial research was also more of an investigation in an effort to define problems in the current situation of the field of studies.

2. Research question conceptualisation : early outcomes of the investigation

Early outcomes were the basis for the formulation of the research problem and conceptualisation of the question that led at a later step to systematic primary and secondary research steps and procedures. The review of all these current practices, procedures and systems guided the researcher through this study towards the clarification of the novelties of the new framework that this study proposes.

3. Needs assessment: systematic primary research investigation

Based on understanding of various patient related disciplines, patients and healthcare experts on this field were contacted and assisted primary research from the outset of the study until its completion in an effort to capture contemporary structural and conceptual needs. Three different research questionnaires were delivered for the purpose of this study. The first one was delivered for the purpose of the needs assessment step and the other two for the design methodology and evaluation step. This research tool (patient questionnaire) was focusing on contemporary patient experiences during their flow through the healthcare system (Appendix 2).

4. Design methodology and evaluation: systematic literature review and use of research tools

The systematic literature review provided a further understanding of the patient-oriented practices in the field. The literature review was implemented from the outset of the study until its completion. Various primary and secondary sources as well as data and metadata were used for the purpose of the study. At the outset, the study of prominent books published concerning the areas of health informatics, quality measures and practices as well as strategic management science were researched. Emerald Library and EBSCO were visited systematically to research articles relevant to the area of this study. The literature review, together with primary research, that was conducted analysed further the domain of healthcare information systems applications and other sources like ontology practices and methodologies, hospital core processes around the world, performance measurement and evaluation systems and electronic interoperability and integration within the hospital premises. In order to fully comprehend all the contemporary frameworks and their application results another two questionnaires were delivered. First, the doctor questionnaire that focused on analytical investigation of the current patient flow design (Appendix 3). Then, the system evaluation of the proposed redesign conceptualisation and implementation was delivered through an OS evaluation questionnaire that focused on evaluating the proposed patient flow framework (Appendix 7).

Finally, these methodology steps and procedures guided this study towards the realisation and implementation of the novel approach that this study suggests.

3.3.2 Conceptualising the Research Question

The next level of this study will lead to answers regarding the research question based on methods employed to provide a proposed framework for that level. One level of this study was the literature review that systematically focussed on the various disciplines relevant to the study. During the next level, the needs assessment reveals parameters like effectiveness, efficiency, accessibility that demand attention, as they are relevant to the subject under study. These issues are relevant to measuring and implementing patient satisfaction and treatment during the patient flow process. At each level, this study introduces the methodology framework for the implementation of this new, ontology-based patient-oriented system for measuring the patient-flow process. The aim is a process that will ensure patient-orientation through measurable ontology-oriented transactions.

3.3.3 Needs Assessment

Once the academic insight of the medical information science was comprehended, surveys relative to patient satisfaction and patient-oriented services were conducted in an effort to capture the current situation of the healthcare processes of the Northern Greek hospital environment.

The aim of the surveys conducted was to capture the satisfaction and treatment levels of the patients' and doctors' view of the contemporary healthcare services received as well as to highlight the structural problems generated by the current healthcare processes relevant to patient flow.

The surveys conducted were delivered to patients and doctors in the area of Northern Greece. During interviews and observations with the survey group, formal and informal discussions and interviews were also implemented with clinical staff and doctors for the purpose of validating certain answers that were generated from the survey participants. The interviews with the survey participants as well as the clinical staff and doctors followed the questionnaires provided in this study's appendices. The principal reason for these interviews was to clarify in greater detail the current, hospital-centred patient flow processes in northern Greece. The questionnaires included structured questions that were easy to evaluate. The questionnaires can be found in Appendix 1. The questionnaires were used as a common platform for the various interviews conducted, where all participants had the opportunity to express their opinion on the questionnaire's issues as well as the way that current healthcare practices are carried out.

3.3.4 Analysis and Design Methodology

The study continues from initial literature review and needs assessment to the analysis of the US as well as the development of the OS. Selective major applications of relevant patient-oriented systems to hospitals around the world will be examined. Considering that the new proposal is relevant to these managerial and information systems, this study, through the DEMO design and reengineering methodology, aims at the conceptualisation and implementation of a novel healthcare system (OS) of patient flow. Currently based on methods engineering, a substantial number of redesign efforts have been implemented in many industries. As methods engineering is characterised as an intuitive effort that is difficult to systemise, many reengineering commercial efforts are rather more practical than scientific (Wand and Weber, 1995). Enterprise ontology by DEMO methodology will bridge this lack of science especially for the organisational reengineering nature of this study. In order to make the ontological model and software system produced more efficient, computer aided engineering design language Xemod will be used as a designing tool for capturing the concept of this study.

The patient flow process will be the core process to be studied, analysed, redesigned and measured in this structured framework. The study's survey as well as the literature review on patient-oriented measures provides ground for the new ontological model, initialising the first action in the methodology that is followed for the analysis, design and development of the model presented. There is no single correct methodology for ontology development. Many ontological disciplines were studied in order to introduce the DEMO methodology as the appropriate one for the nature of this study. The DEMO methodology is based on the semiotic triangle (Bunge, 1977) and the ontological parallelogram (Dietz and Baris, 1999) and is introduced by the enterprise ontology discipline that will be analysed later in this study. In brief, the DEMO methodology adopted follows the steps below when designing an OS:

1. The Performa-Informa-Forma Analysis.
2. The Coordination-Actors-Production Analysis.
3. The Transaction Pattern Synthesis.
4. The Result Structure Analysis
5. The Construction Synthesis.
6. The Organisation synthesis.

Table 3.0: The DEMO Methodology OS Design Steps

The DEMO methodology, based on the Dietz engineering and design tools in table 3.0, aims to analyse the domain of discourse of the contemporary problematic situation of the patient flow and then use them for the novel design of the proposed future situation (Dietz, 1999). The hierarchical utilisation of these tools forms the basic methodology steps for the Dietz redesign process adopted in this study, which is further analysed in the systems analysis and design methods chapter five (Figure 5.6: The Adopted Redesign Process). Thus, there is the world of elective patients and their flow through the healthcare system. Elective patients are considered those that are in the position to decide regarding their treatment process. Non-elective patients are those that, due to an emergency situation, are not able to decide regarding their treatment process, and they are thus unable to proceed with autonomy. A state of such a world can be conceived as a set of elementary facts that this world includes, such as the fact of the specific patient type or hospital policy or general practitioner's policy for this particular patient (Sure, Tempich and Vrandecic, 2006).

Table 3.0 presents the necessary steps to be followed for the implementation of the systems analysis and design phase. Each step includes all the necessary requirements that have to be adopted to implement this patient-oriented framework necessary for the solution of this problematic situation. So, the need for the conceptual foundation that provides concepts and structures to be represented and comprehended through redesigning is delivered with enterprise ontology and DEMO methodology (Dietz, 1999). In sum, this scientific rather than practical redesign methodology and its application to the contemporary problematic situation to create patient-oriented flow is this study's main novelty.

3.3.5 System Evaluation

This study tackles issues that are relevant to the problematic area of patient-oriented services that have to be identified and solved. A priori power analysis is conducted prior to the research study and is typically used to determine an appropriate sample size to achieve adequate power. The evaluation methods as well as tools that are going to be used, focus on the patient-oriented flow process that will be reviewed in an effort to solve the contemporary problematic situation. Several methods in a literature review could be found that relate to systems development. Important requirements for this system evaluation are the qualitative knowledge base and the system's practicality. More specifically, the evaluation methodology considered for the purpose of this study has to be able technically to take into account the necessity of the ontological construction model and practically the conceptual framework's usability. Objectives like generality, efficiency, perspicuity, precision and minimalism have to be taken into consideration for the evaluation methodology selected.

The questionnaires that were delivered for the purposes of this study to patients and clinical staff as well as the doctors' interviews are hierarchically delivered as follows:

- The management question
- The research question
- The investigation question
- The measurement question.

Similar structured questionnaires were also used in interviews conducted in addition to the above indicative framework's objectives necessary for the system's evaluation.

3.4 Research Tools

A series of tools was used for the purpose of this study according to the analysis and design reengineering methodology that is being delivered through the enterprise ontology. In the needs assessment phase of the contemporary situation, the implementation of a Northern Greece healthcare environment survey was delivered. Questionnaires were also delivered followed by a series of interviews and observations. For the analysis and design the DEMO methodology will be applied. Most of the DEMO enterprise ontology tools were designed electronically within the software tool Xemod, initiated in 2008.

Finally, for the evaluation stage, in addition to the Xemod ontological software package of OWL language, CLIPS expert systems language was also used for capturing the knowledge produced for the patient flow to potentially simulate the implementation of the patient-oriented performance system introduced. This system was presented to a team of doctors to evaluate the systems' practicality as well as its feasibility regarding the aim of this study. The evaluation framework and the evaluation results are demonstrated in the evaluation chapter of this study.

3.4.1 Survey Design

For the proposed survey, questionnaires were developed as well as a series of visits. The purpose of the questionnaires was to understand the current situation inside Greek hospitals regarding patient-satisfaction levels, exposing problems, identifying personnel training needs and defining some necessary core measurements. Analysis of the results obtained in the next section demonstrates the level of awareness in regard to such qualitative issues. Using a hospital or a number of individuals, the questionnaires were tested for possible misunderstandings according to the basic pre-testing, one-case methodology (Kirk, 1982).

The objective of the questionnaires was to reveal to what extent the respondents were satisfied with the primary and secondary healthcare system at the national level. There was no way to judge the patient–orientation of the system's processes effectiveness, as it was not possible to measure a priori the respondent's knowledge of the issue. Thus, this method was implemented due to the specific nature of the questionnaires, which aimed at detecting basic knowledge and behaviour towards such an issue (Edwards, 1972).

3.4.2 Questionnaire Design

The basic pre-testing one-case methodology method will not be used further, as it fails to correlate the independent variable, the patient treatment, with the dependent one, the rest of the measurements. A true experimental design, as later presented in the needs analysis chapter, will be included for further research as it will make use of the pre-test post-test control design. For the structure of the questionnaires, several basic parameters were introduced (Krathwohl, 1985).

The questionnaires were distributed by personal visits of the researcher following a telephone call. The sample size exhibited in the next chapter (that of 70 people) is much larger than the minimum sample of thirteen that is necessary for a statistically sound analysis (Cornford et al., 1996). The questionnaire is one page long and it is easily comprehended. The developmental methodology of the survey is given below:

A. Qualitative Analysis

- Question hierarchy. The researcher tried to move from the general managerial concept of consumer satisfaction to specific core questions using basic measurement levels of patient flow.
- Communication mode and process structure. Clearly the decision taken to use questionnaires, interview and follow up phone calls gives the survey a solid structure. The interviews provided the researcher with a greater level of understanding. Focus groups were not used due to the qualitative nature of the general concept. There was the risk of losing the focus of the discussion if focus groups were used, as the nature of the problem was rather straightforward, whereas there was a need for much specificity to debate.
- Objective disguise. Another consideration that puzzled the researcher was whether the purpose of the study should be made explicit, that is, the evaluation of patient satisfaction services and treatment. It is assumed that such knowledge could not bias the results. The respondents on a conscious level were aware of the services received.
- Data-Gathering Process Decisions. At this stage the researcher had to choose the means of the data gathering: personal or impersonal? Despite the wide geographical dispersion of the respondents and budget limitations, due to the nature of the data, personal interviews were conducted. Thus, the structure of the questions, largely affected

by the communication mode, was designed based on personal interviews.

- Question content. Next, the researcher considered the question coverage of these preliminary questionnaires for the purpose of problem identification. Questions are inadequate if they do not provide the information needed to interpret responses fully. Minimizing the number of questions was critical, as the subject matter was sensitive and personal. The researcher also included direct questions as the nature of the problem was such that the respondent could be more helpful than usual.
- Question wording. To avoid any misunderstanding, which is a rather frustrating experience for the researcher, the vocabulary used in Greek for the preliminary problem identification questionnaires was rather simple. No biased words or personalised questions with many alternatives in closed answers were given.
- Response structure. The most important role of the questionnaires is to derive excellence in information. Most of the questions exhibited follow a closed-ended approach; that is, they offer an adequate number of specified alternatives. An open-ended approach, which includes questions that allow a free choice of words in return, was also used for proposals or comments relevant to the issue.
- Question sequence. In an effort not to receive a biased answer from the respondent, the sequence of the questions and their organisation was arranged to quickly engage the respondent's interest. In addition, the questioning process started with simple questions and moved to more complex ones (Payne, 1986).

B. Quantitative Analysis

The parameters below will be included in the following chapter that analyses the preliminary questionnaires quantitatively (Hammer et al., 1993):

- Data preparation
- Data presentation
- Result Interpretation

The analysis phase, in later chapters, will assist in understanding the core aspects of the problem that currently exist. The next phase of the current-situation analysis is the system's design phase. However, at this point the flowchart of the sum of the activities, which add value to consumer satisfaction, will not be considered (Baron et al., 1999).

Based on such a transactional diagram, the necessary documentation will be built presenting both the data-logical and info-logical aspects of the proposed framework. The aim of the questionnaires was to provide a brief and clear summary of the current situation of patients' satisfaction levels that are present in the healthcare industry in northern Greece. This chapter's questionnaires tried to identify gaps or insufficiencies in the satisfaction levels that a patient receives from the moment he/she contacts healthcare system until the moment he/she leaves. In later chapters, based into the same survey methodology, questionnaires will also be delivered to other system actors (e.g., healthcare managers and doctors) to further analyze current structural problems of the patient flow.

This survey approach used in the questionnaires included seven closed-ended questions and two open-ended questions. Closed-ended questions are those questions that can be answered finitely by either "yes" or "no" and are also known as dichotomous or saturated type questions. However, since the purpose of the questionnaires was to measure attitudes, preferences, and subjective reactions, the response scale used was a Likert scale, which helped obtain the emotional and preferential responses of inquirers. The questionnaires presented a set of attitude statements and subjects were asked to express agreement or disagreement on a five-point scale (Malhotra et al., 2003).

In addition, two open-ended questions were included in the questionnaires to allow an unrestrained or free response from the inquirers. Open-ended questions may solicit additional information from the inquirer and are sometimes called infinite response or unsaturated type questions.

The questionnaires were administered to two categories of patients: 1) ex-patients that had been in hospital within the previous three-month period, and 2) patients that were in their last stage of their stay. Before giving out the questionnaires to each patient, an appointment was made with the ex-patients to explain the purpose and intent of the questionnaires to avoid any possible misunderstandings at the checkout stage for the patient group. The former received the questionnaires by hand, whereas the latter received the questionnaires from the researcher's team during the checkout process. The responses were collected within a three-month period from January 3rd to April 10th, 2006.

The questionnaires elicited responses from 70 people and from 8 different hospitals, 3 from the private and 5 from the public healthcare industry. The responses were collected from the area of Thessaloniki, which is the second largest city in Greece. The anonymity of the respondents was guaranteed, since for the purpose of the survey, the names do not affect the results (Bulter, 1994). On the other hand the sample's demographic data is analysed in Table 3.1.

Age Gender	20-35	35-55	55 & above	Grand Total
Male	15	20	3	38
Female	9	11	12	32
Grand Total	24	31	15	70

Table 3.1 Sample Demographics

3.4.3 Question Hierarchy

The research question hierarchy is of great importance. It is important, as an exploratory investigation is necessary to assure that one understands the dimensions of healthcare services. The topics that the questionnaires tried to examine were the following:

- Levels of patient satisfaction received from the hospital's services
- Levels of patient satisfaction received from the hospital's nurses

- Levels of patient satisfaction received from the hospital's doctors
- Levels of patient satisfaction received from the hospital's support personnel
- Levels of patient satisfaction according to hospital type (public or private)
- Adequacy and availability of medical equipment for examinations and tests to take place
- Adequacy of medical equipment in public and private hospitals
- Time needed for office services to cover patient's needs concerning paper work
- Presence of understanding in the hospital.

The following questions/statements were designed for the questionnaires. Most of them need a tick among a five-point scale answer; one needs a tick in a Yes/No type question and two are open-ended questions, where the subject is provided with space to write down his/her thoughts, complaints or suggestions, in case there are any. The questionnaires can be found in the appendices section.

All the questions are cohesive with the philosophy of moving from the general management objective (patient satisfaction) to specific measurement questions (patient-oriented measurements for the patient satisfaction).
Hierarchically, the management question deals with the problem that has to be answered. That is question number one (1) that asks the level of patient satisfaction for the specific clinic and hospital. The research questions (2-9) that follow are relevant to the contribution to the solution of the management question (patient satisfaction). They are also of investigative nature, as they are very specific to answer the research question. They are both closed- and open-ended type questions in an effort to move from the general managerial question to specific research questions.

3.4.4 Questionnaires Piloting

The questionnaires were piloted on three individuals, one medical student that was doing her clinical internship in a public hospital, one 65-year-old male patient and one pathologist, with whom the researcher has a close relationship. The experience of the medical student and the pathologist proved to be very helpful in the final design of this study's questionnaires. As a result of the piloting procedure, some questions were eliminated and some were modified to make them easier for the respondents to understand.

3.4.5 Interviews

According to Kahn Davis and Kosenza (1988), the people selected to be a part of the sample should be interviewed in conference rooms or offices. All interviews implemented for the purpose of this study were conducted at the researcher's office at the American College of Thessaloniki. The possible outcome of this kind of interview was that the interviewees described their demands during their stay at the hospital relevant to the questionnaires.

For the purpose of receiving opinions other than from patients relevant to this study, a series of interviews were carried out at the interviewees' offices at the hospital or their private facilities. In that way, most of the patient flow stakeholders were interviewed. Such kinds of interviews follow the completion of the questionnaires presented in this chapter as well as in chapter nine. The interviewees thus have the opportunity to express their expert opinion based on the questionnaires delivered. All questionnaires anonymity and confidentiality is guaranteed.

3.5 Questionnaire Statistical Analysis

The approach used for data analysis is both confirmatory (Confirmatory Data Analysis) and exploratory (Exploratory Data Analysis). The EDA approach has many variations that all share principles pioneered by John Tukey (1977). EDA determine the analysis or its revision rather than the analysis presuming to overlay its data structure without the benefit of the analyst's work. EDA focuses on visual representations that give a solid trend to the research results. In this way, the research ensures its problem orientation rather than the tool orientation. Although CDA should also be used with numerical statistics that complete the statistical analysis, as EDA many times leads to flawed assumptions. The researcher with EDA has no power over data manipulation based on scientific tools and thus can not bias the evaluation of the data presented.

It is believed that EDA is more efficient at this initial point, as it leaves space only for visual evidence, but with the addition of the CDA the strength of the evidence found could not be ignored. This evidence will be strengthened, proved and evaluated in latter chapters.

Analyzing the data collection from the questionnaires was the next step in the procedure. In order to visualize the results of the questionnaires through a quantitative analysis, the statistical package PHStat2 of Prentice Hall was used (www.prenhall.com). Table results, from table 3.2 to table 3.11, are rounded up to the second decimal figure. A codebook table is presented in table 3.2, which is a summary of the entire questionnaires showing the position of the fields and the key to all the codes. The codebook contains instructions and the necessary information about the survey questions.

Column	Question	Question number	Coding Instructions
A	Name of Patient		Number from 1 to 52
B	Name of Hospital		Name of Hospital
C	Type of Hospital		Public=1 Private = 2
D	Satisfaction received from hospital's services	Q1	Strongly Agree = 1 Agree = 2 Neutral = 3 Disagree = 4 Strongly Disagree = 5
E	Satisfaction received from nurses	Q2	Strongly Agree = 1 Agree = 2 Neutral = 3 Disagree = 4 Strongly Disagree = 5
F	Satisfaction received from doctors	Q3	Strongly Agree = 1 Agree = 2 Neutral = 3 Disagree = 4 Strongly Disagree = 5
G	Satisfaction received from support hospital personnel	Q4	Strongly Agree = 1 Agree = 2 Neutral = 3 Disagree = 4 Strongly Disagree = 5
H	Adequacy of medical equipment	Q5	Yes = 1 No = 2
I	Office services - time vs. completion of paper work	Q6	Very fast = 1 Fast = 2 So and so = 3 Slow = 4 Very slow = 5
J	Presence and communication level in the hospital	Q7	Strongly Agree = 1 Agree = 2 Neutral = 3 Disagree = 4 Strongly Disagree = 5
K	Complaints	Q8	If yes, subject writes down the complaints in the space offered.
L	Suggestions	Q9	If yes, subject writes down the suggestions in the space offered.

Table 3.2: The Coding Table

Table 3.3 lists all the hospital names that participated in the research.

Name of Hospital	Total	
Military Hospital 424 (424 ΓΣΝ)	11,43%	8
St. Lucas (ΑΓΙΟΣ ΛΟΥΚΑΣ)	12,86%	9
St. Paul (ΑΓΙΟΣ ΠΑΥΛΟΣ)	11,43%	8
Ackepa (ΑΧΕΠΑ)	15,70%	11
G. Clinic (ΓΕΝΙΚΗ ΚΛΙΝΙΚΗ)	12,86%	9
Diavalkaniko (ΔΙΑΒΑΛΚΑΝΙΚΟ)	12,86%	9
Papageorgeou (ΠΑΠΑΓΕΩΡΓΙΟΥ)	11,43%	8
Papanikolaou (ΠΑΠΑΝΙΚΟΛΑΟΥ)	11,43%	8
Grand Total	100,00%	70

Table 3.3: The Hospital Table

These eight hospitals are all located in the greater Thessaloniki area. They are all considered the most frequent in patient selection based on their insurance. The hospital mix exposed is close to 39% from the private sector and close to 61% from the public (see Table 3.4).

Public/Private	Total	
Public	43	61,43%
Private	27	38,57%
Grand Total	70	100,00%

Table 3.4: Public/Private Table

The grand total of the questionnaires adds up to 70. The first question requests satisfaction level of the services that the patient received in a hospital environment. Table 3.4 analyses the results of this question.

Satisfaction - Hospital Services			
Q1	Public	Private	Grand Total
Strongly Agree	0,00%	8,57%	8,57%
Agree	7,14%	25,71%	32,86%
Neutral	37,14%	4,29%	41,43%
Disagree	15,71%	0,00%	15,71%
Strongly Disagree	1,43%	0,00%	1,43%
Grand Total	61,43%	38,57%	100,00%

Table 3.5: Satisfaction – Hospital Services

In the first question, as is the case around the world, it is detected that most patients felt they received average healthcare service. The second question requests satisfaction level regarding the services that the nurses provide to a patient in a hospital environment. Table 3.6 analyses the results of this question.

Satisfaction – Nurses			
Q2	Public	Private	Grand Total
Agree	8,57%	11,43%	20,00%
Neutral	34,29%	24,29%	58,57%
Disagree	15,14%	4,86%	20,00%
Strongly Disagree	1,43%	0,00%	1,43%
Grand Total	59,42%	40,58%	100,00%

Table 3.6: Satisfaction - Nurses

In this second question it was detected that most patients felt they were receiving average service from their nurses. The third question requests satisfaction level of the services that the doctors provided to a patient in a hospital environment. Table 3.7 analyses the results of this question.

Satisfaction – Doctors			
Q3	Public	Private	Grand Total
Strongly Agree	0,00%	4,29%	4,29%
Agree	9,43%	27,71%	37,14%
Neutral	35,29%	6,14%	41,43%
Disagree	13%	1,43%	14,42%
Strongly Disagree	2,72%	0,00%	2.72%
Grand Total	60,44%	39,56%	100,00%

Table 3.7: Satisfaction - Doctors

This question is strictly related to the doctors' communication level and not their expertise. The fourth question requests satisfaction level of the services that the support personnel provided to a patient in a hospital environment. Table 3.8 analyses the results of this question.

Satisfaction - Support Personnel			
Q4	Public	Private	Grand Total
Strongly Agree	0,00%	1,43%	1,43%
Agree	8,57%	11,43%	20,00%
Neutral	37%	25,86%	62,86%
Disagree	12,86%	1,43%	14,28%
Strongly Disagree	1,43%	0,00%	1,43%
Grand Total	59,86%	40,14%	100,00%

Table 3.8: Satisfaction – Support personnel

The support personnel also scored an average level of satisfaction. The fifth question requests regarding availability of the necessary medical equipment provided to a patient in a hospital environment. Table 3.9 analyses the results of this question.

Availability of Medical Equipment			
Q5	Public	Private	Grand Total
Yes	42,86%	38,57%	81,43%
No	18,57%	0,00%	18,57%
Grand Total	61,43%	38,57%	100,00%

Table 3.9: Availability of medical equipment

This question is directly related to the previous point, as it clearly shows a significant availability of medical equipment, especially in the public sector. The sixth question requests satisfaction level of the services that managerial personnel provided to a patient in a hospital environment. Table 3.10 analyses the results of this question.

Satisfaction - Services & Paper Work			
Q6	Public	Private	Grand Total
Fast	2,86%	11,43%	14,29%
So and so	34,29%	25,71%	60,00%
Slow	21,43%	1,43%	22,86%
Very slow	2,86%	0,00%	2,86%
Grand Total	61,43%	38,57%	100,00%

Table 3.10: Satisfaction & Paper work

The results of this question were disappointing. This issue demands a great deal of research for the necessary framework available at the point of service. The seventh question requests the presence of understanding from all clinical personnel towards the patient needs in a healthcare environment. Table 3.11 analyses the results of this question.

Presence of Understanding			
Q7	Public	Private	Grand Total
Agree	4,29%	22,86%	27,14%
Neutral	24,29%	15,71%	40,00%
Disagree	28,57%	0,00%	28,57%
Strongly Disagree	4,29%	0,00%	4,29%
Grand Total	61,43%	38,57%	100,00%

Table 3.11: Presence of understanding

Overall satisfaction level that is highlighted through the patient's perception regarding the level of understanding is average. A series of comments included in an appendix actually put that perception into words. Also a table with some proposals is interesting for further research. The eighth question also included in the same appendix requests any complaints regarding the level of the services a patient received in a hospital environment.

3.6 Summary

This chapter describes this study's general research methodology and provides evidence for problem identification and its solution. A clear definition of the problem will lead to patient-oriented research and its current practices using the DEMO methodology and tools presented in this chapter and later analysed at level three of this study (see Figure 1.5).

A systematic literature review on consumer-oriented strategies and systems as well as patient-oriented strategies and systems carried out in this study will lead to the need for the new framework proposed. The prototype ontology-based framework that will be initiated will be analysed, evaluated and presented to ensure cohesiveness with the basic contemporary patient flow practices, as they vary at least geographically. The healthcare world of ontology includes actors that posses certain roles according to their authority. Patients do not possess the necessary authority or competence to cure themselves properly. It is impossible for the patient to accurately judge the correct or incorrect methodology used for an operation or treatment unless there is evidence. Evidence is necessary to compare opinions between system actors that have the authority, competence and responsibility to deliver a second opinion. These actors, subjects, are the doctors. This study aims to include within specific patient flow transactions steps that will provide the necessary evidence, and then based on leading measures to ensure patient satisfaction and treatment.

Once again, as noted in chapter one, there is great difficulty in establishing cohesive ontological based health measurements. Thus, this study, despite not trying to establish international standards, is trying to introduce a novel scientific approach to redesigning healthcare flow based on DEMO, which allows reengineering implementation to design a patient-oriented flow on a national level.

The next chapter takes this study to the next level of its structure. Further analysis of systems and design methods as well as its consumer and patient-oriented practices around the world are exhibited and analysed.

Chapter 4 Systems Analysis and Design Methods

4.1. Introduction

The issues identified in the literature review chapter define the framework for the model and its supporting information system design. According to this study literature review, reengineering practices are empirical rather than scientific. On the other hand the international efforts and solutions that have been thoroughly examined and presented in the previous chapter must be considered to design a novel framework according to Dietz (1999) redesign methodology, which thereafter will be referred to as the Object System (OS). For successful OS concept implementation, the necessary ontological transactions and measures, as exhibited in the next chapter, will have to be introduced. Within this frame, they are categorised according to the process model of the value chain of activities approach, as presented in the literature review chapter, which applies to any industrial environment creating competitive advantage. Based on this value chain process approach for redesigning, ontology methodology takes into consideration core transactions that directly affect the patient flow process as presented in the previous chapter's initiatives. The novelty to the redesigned patient-oriented flow process is that the OS focuses on the patient's treatment and satisfaction using enterprise ontology. Theoretically it will have to fulfil minimum measurable results that could derive from both the OS design which includes the patient flow model and its supporting information system which is referred to in the next chapter as POMR (Patient-oriented Management and Reporting System). The Supporting information system of POMR, according to Juhani and Hirchheim, is "an organized collection of concepts, methods, beliefs, values and normative principles supported by material resources" (Juhani and Hirschheim, 1998). Although there are clearly different approaches to information systems design, these differences are procedural rather than substantive in nature (Hirschheim and Klein, 1995). Specifically Ivary and Hirschheim (2000) initiate a useful framework for relating the classical ISD methodologies with several other design methodologies and approaches. As the concept of this study focuses on structural issues of this flow, the enterprise ontology approach to reengineering and DEMO methodology assist in relating the conceptual social and technical information perspectives of this study.

The international efforts and solutions that have been thoroughly examined and presented in the previous chapter must be considered to construct the foundation of the OS. Based on business modelling, ontology methodologies introduce a value chain process model for redesigning core transactions that directly affect the patient flow process as presented in the previous chapter's initiatives. The novelty of the restructured patient-oriented flow process in addition to the use of ontology is that the patient's routing is designed with primary focus on the patient-oriented concept of this study. Theoretically this OS could fully implement this study's concept with measurable patient-oriented results which derive from the enterprise ontology model. Enterprise ontology as presented in chapter three (Table 3.0) is a useful tool for developing intelligent systems, as well as for the knowledge redesign process. The use of ontology in this study's framework provides the necessary methodology for the implementation of the proposed patient flow concept as it is able to produce the following:

1. Exact definition of the subject area. It will define the exact patient-oriented flow concept. The definition of a patient-oriented flow concept provided in the next chapter through ontology leaves no space for the contemporary, unambiguous interpretations of the term. According to the literature of this study the patient-oriented flow is interpreted differently in natural language and thus these terms are not suitable for machine processing. Although there are thesauri providing certain semantics in a form of synonym relationships between terms they do not provide the explicit terms hierarchy, rules and parameters which are required for a proper definition. Ontology is different from human oriented vocabularies as it provides logical statements describing the domain of this study (McGuiness, 2002). It also specifies rules for combining the patient-oriented concept term and its relation to define conceptualisations necessary to capture the concept of this study.

2. Concept hierarchy (taxonomy). Ontology will cluster healthcare entities providing a full specification of the domain of this study. It will assist interpretation of the degree of patient orientation for a result-based service on the rules and taxonomy of the object system produced.

The literature review of this study provides the necessary evidence for the leading measures proposed at data-logical and info-logical level presented in the next chapter. These measurements based on the balanced scorecard approach will ensure patient satisfaction and treatment in every transaction. This patient-oriented approach of the patient flow process has to be tested and measured for its applicability (Thomson and Stickland, 2005). This new system will fulfil the needs presented in the previous chapter and will be evaluated accordingly in chapter eight of this study.

4.2 Brief Review of Ontology Development Methodologies

Historically, since the early development stage of similar frameworks there have been various endeavours to design and implement such systemic approaches (Winston, 1970).

Later, during the 1980's several methodologies relevant to process and data modelling were prominent. Today, there are several fundamental philosophical assumptions for different information systems development approaches such as the interactionist approach, the language/act approach, the professional work practice approach and others. The language/act approach has been adopted in this study through the DEMO methodology. Finally today, most system developers are considering methodologies relevant to object-oriented approaches that have led to ontologies (Corcho, et al., 2002).

Specifically, ontology development methodology includes a set of cohesive principles, processes, practices, methods and activities used for designing, evaluating and implementing ontologies. Basic characteristics of all these ontology methodologies according to surveys in this field (Staab and Stuber, 2004) are three basic categories which conclude that:

1. Most ontology development methodologies focus on building ontologies.

2. Other methodologies, like the DEMO methodology, also include methods for merging, reengineering, maintaining and evolving ontologies.

3. Yet other methodologies build on general system development processes and practices and apply them to ontology development.

There is no ontology considered to be the best or correct way for building a framework's domain. On the other hand, ontology development is an iterative process. Some of the methodologies included in the above three categories for ontology development are rather simplistic others rather complex. A simplistic methodology example of the first category is the one proposed by Noy and McGuiness (Noy and McGuiness, 2001). Others that belong in the second category like Van der Vet and Mars (Van der Vet and Mars, 1998) are not as simplistic, since they are focus on the bottom-up construction of ontological processes. Another more comprehensive methodology of the same category is the Menthontology framework (Fernandes-Lopez et al., 1999) useful to build ontologies from scratch or for reusing other ontologies. Similar to this methodology, Business Process Modelling (BPM) methodology that is amenable to automatic analysis based on business process simulation is a powerful method to capture business processes. The specific method proposed, which is based on the innovative language-action perspective is called Designing and Engineering Methodology for Organisations (DEMO), which is used for building ontologies from scratch and for reengineering processes through ontologies. Finally, in the third category, an ontology development methodology similar to object-oriented software methodology analysis is introduced by Devedzic (2002).

For their implementation phase all of them have used diverse techniques and software for the knowledge representation since their development beginning in the late 1990's.They are roughly categorised as the early ones known as pre-XML era and the later ones known as XML-based. Most of the latter are also called "Semantic Web Languages" or "Web Based Ontology Languages" (OWL) or "Ontology Markup Languages" (Gomez-Perez and Corcho, 2002). Some early languages include Unified Modelling Language (UML) introduced by Cranefield (Cranefield, 2001a&b) or later Model Interchange Language like the Extensible Markup Language (XML) which assists as a standard for serialising the UML models. And the similar but more contemporary language is the Resource Description Framework (RDF), a language mainly used for Semantic Web, or, finally, languages used for BPM methodologies that also allow business process simulation for the technical evaluation stage of the ontology produced include OWL or WOSL. Specifically the Xemod software package is an ontology development tool based on WOSL that has its philosophical roots in

Bunge philosophy (Bunge, 1977). The WOSL software, however, has a broader scope of application the ontological model developed uses its own software modeller according to DEMO which is also based on Bunge's philosophy as expressed by Bunge's Semiotic triangle (see Figure 9.1: The Patient-oriented Semiotic Triangle).

Finally in an ideal world a universal shared knowledge representation language to support Semantic Web, for many pragmatic reasons, is unachievable (Decker at al., 2000). One pragmatic reason is that a tool like Xemod which will be further explained in this chapter also supports other languages. Xemod supports other Business Process Modelling Methods and provides interoperability among them. The system's architecture is an open system allowing the addition of more methods in the future. According to Dietz's enterprise ontology (2006), an indicative list of methodologies that are currently supported by Xemod, 2008 are:

1. DEMO: Design & Engineering Methodology for Organisations. This is the method used and analysed next in this study.
2. ORM: Object Role Modelling. ORM is a widely used method for modelling information. It is the modern variant of Entity Relationship Modelling (ERM). It is an object-oriented methodology that refers to Object types. In Xemod, ORM can be used in conjunction with DEMO to specify the results of the DEMO transactions. It can also be automatically transformed in to UML Class diagrams, for example.
3. EPC: Event driven Process Chains. EPC is a widely used method for Analyzing and specifying business processes and thus is relevant to the nature of this study. It has been developed by Professor August W. Scheer in Germany.
4. UML: Unified Modelling Language. The UML is currently the most widely used software specification language. It was developed by Ivar Jacobson, Grady Booch and James Rumbough. The language's methodology is based on the object-oriented modelling paradigm.
5. Flow Chart: The flow chart method is probably the most widely used diagramming technique for engineering business models. It could be used for designing business processes used to obtain HACCP or ISO certification. Xemod allows the user to connect these flow charts with DEMO Actor Transaction Diagrams.

The same case is true for Protégé, the most common ontology development software package used in healthcare, initiated to assist the Noy and McGuiness ontology methodology. There are also another dozen tools for ontology development although all of them are limited to certain languages and require enhancements in the form of higher level knowledge representation allowing more model flexibility (Denny, 2004). Specifically, there are different domains of ontology for higher level knowledge representation that could be approached with a slight variation as far as the terminology is concerned. There are many different domain ontologies, which are claimed to provide a greater level of formal rigour than coding systems or terminologies (Harris et al., 2000). In a way such domains will be more understandable for software applications rather than for human related processes like this study's focus.

The next section will historically present some recent ontology and relevant ISD methodologies through three basic categories of ontology and their development tools in an attempt to present the appropriateness of the enterprise ontology and the DEMO methodology for the analysis of this study's domain. The three basic types of ontology development vary, as the first category focuses on building ontologies, the second on reengineering, maintaining and evolving them and the third on building general software development processes and their application to ontology development.

4.2.1 Object-Oriented Methodologies

The object-oriented methodology is actually a rather contemporary approach. This methodology builds a model based on objects which express certain behaviour. The method focuses on objects that combine structure and behaviour in a single entity. By identifying the objects characteristics, behaviour and knowledge about the real world, the object-oriented methodology provides an organised model. It is considered valuable for analysis and design of engineering systems which actually produce measurable and predictable results. (Martin and Odell 1998).

The object-oriented methodologies, much like contemporary ontologies form classes of a system. Enterprise ontologies, with the latest methodology DEMO, upgrade the systems analysis step of the methodology by dichotomising between objects and subjects in the produced model's structure, as it also delivers a higher degree of actors' correlations. The ontologies and their three basic schools of thought, as described in the introduction of this chapter, are presented next in an effort to fully display the method's structural design approach and its conceptual foundation.

4.2.2 The Noy and McGuiness Ontology Methodology

The Noy and McGuiness Ontology Methodology (Noy and Mc Guinness, 2001), belongs to the first ontology category and thus is better used for specific ontology development processes. It suggests the following steps for the development of ontology information systems:

1. Determine the scope and domain of ontology. In this step what the ontology domain will cover is clarified: the reason for using the ontology as well as the questions that the ontology will answer. The users of ontology are also very important at this step.

2. Consider reusing existing ontologies. It is wise at this step to check previous work relevant to the ontology's domain under development.

3. Enumerate important terms in the ontology. The user should be familiar with the terminology and its relevance to the ontology's domain.

4. Define the classes and the class hierarchy. A class hierarchy at this point could be developed bottom up or top down as a combination of the previous two. The best hierarchy approach depends on the domain under consideration.

5. Define the slots and the facets and their cardinality. Slots have different facets describing the value type, allowed values as well as the number of values. In a wine selection example the slot "wine name" could describe the wine's brand and the slot "wine producer name" could describe the producer of this wine. So "name" slot is a slot with a value type or facet of a string.

6. Create instances. This means that each instance should include all the slot values. Therefore, first a class is chosen, then an individual instance for this class, and finally this slot should be filled with the relevant facets or value types. For example the “Châteaux Carras Beaujolais” wine is a specific type of Beaujolais wine. “Châteaux Carras Beaujolais” is an instance of the class Beaujolais wines that have specific value types like: colour should be red, flavour should be delicate, or taste should be dry.

The above methodology is much more complicated in practice as there are several sub-processes to be examined. Usually time consuming iterations could provide a minimum understanding about the final ontology delivered. The proposed software tool using OWL language for the development of this ontology methodology is Protégé software package.

4.2.3 The Methontology Framework Methodology

The Methontology framework (Fernandez Lopez et al., 1999), much like the DEMO methodology, belongs to the second category of ontology development of reengineering maintaining and evolving ontologies. Methontology’s initiation point is that ontological engineering must be well defined and standardised through out the ontology life circle, similar to the waterfall model. Therefore, this framework includes:

1. Identification of the ontology development processes and sub-processes. This step includes the ontology’s terminology, primary objective, purpose and scope. It also conceptualises the structure of the knowledge acquired though the implementation of the concepts, hierarchies and relations of the model under development.

2. A development of a life circle based on developing prototypes.

3. The actual methodology should specify the steps for performing each activity, the techniques used and the results or rather the products of each activity

4. Finally an evaluation procedure is in order similar to the waterfall model.

This category of ontology development focuses on the use of various knowledge acquisition techniques. According to this category, to develop practical knowledge it is necessary to acquire explicit human knowledge and transform it into various representation formalisms using specific tools and techniques and then validate the knowledge base created by running an intelligent system simulation. Thus, this category is best for reengineering, maintaining and evolving ontologies.

4.2.4 The Object-Oriented Devedzic Methodology

This third category of ontology development initiates an ontology development methodology similar to the object-oriented analysis (Devedzic, 2002). Ontologies represent concepts' properties, and values. They also encompass some kind of cardinality and generalisation ("part of"). All these parameters are very similar to the object-oriented analysis and design. Object-oriented analysis focuses on different aspects from those that ontological analysis does, but they are very much alike.

Thus, on the one hand, both methodologies use various templates or facets for specifying details of their objects (see the wine example in the previous section). They both are also built on the concept of design patterns to solve specific problem domains. They both encompass explicit knowledge, and through AI simulation, tacit knowledge is possible. Finally both are used for defining concepts and representation of explicit knowledge.

On the other hand, ontology and its design patterns are not the same, although they overlap to a certain degree. Nonetheless, certain engineering principles of ontology development are similar to object-oriented software engineering. Applying these model-driven architecture principles taken from software engineering to ontology development is what this last category is all about.

The next section will examine certain ontological development methodologies and models and their relevance to the healthcare sector.

4.3 Ontology Development Methodologies, Models and the Healthcare Sector

Information systems and specifically those related to ontology in the healthcare sector, according to the previous ontological models could be classified in two major categories. The first category includes those that focus on the healthcare processes and their analysis and others that focus on the healthcare structure and its improvement of the delivery of healthcare management.

Relevant to the first category, ontology medical processes include definitions of the main classes of medical procedures, drawing on the UMLS Semantic Network as well as definitions supplied by the Institute of Medicine (http://www.iom.edu). There are different standardisation efforts corresponding to various healthcare activities relevant to ontological practices. Models like the HL7 v3 and DOLCE, presented earlier in this study, are some distinct ontological efforts that are directed towards integration and interoperability. The DOLCE ontology, like the enterprise ontology, is being used in both academic and industrial studies worldwide. The ON9.2 has been aligned with the DOLCE foundational ontology, and efforts are underway to align it with the Basic Formal Ontology (BFO), which is being developed in Leipzig. BFO is a core of several closely related ontological theories proposed in the recent literature (Smith, 2003). The relevance of this first category of ontological models to standardisation issues is important as it assists the further development of this study, as presented in the further studies chapter, by establishing interoperability at data-logical organisational level.

It is obvious, on the other hand, that this study belongs to the second category of ontology information systems and methodologies that are trying to redesign certain healthcare processes in an effort to improve the quality in healthcare management. Thus, the interest is focused on BPM methodologies where the DEMO methodology based on business process implementation is a powerful method to capture measurable qualitative business processes. It is important to underscore once again that the healthcare sector is different from other commercial sectors due to data confidentiality, which leads to important decisions relevant to people’s lives. As most ontology methodologies are mainly developed for commercial use, the supporting information system of the ontological model should be able to include and measure to a certain extent the critical parameters of the healthcare sector, which is trying to identify essential needs and is different from commercial organisations. Enterprise ontology is relevant to definitions relevant to business organisations.

There are several steps in the healthcare sector relating to the creation of knowledge for healthcare. Therefore, in the literature review, the existence of already established and commonly accepted definitions, standards, classifications, schemes and ontologies regarding this domain were explicitly presented. As far as specific ontological efforts, mostly based on the Noy and Mc McGuinness methodology (Noy and McGuinness, 2001) and designed through the Protégé project presented earlier in this study, the following basic projects which assist towards the quality development of healthcare include:

✦ Relative to existing healthcare medical classifications, terminologies and taxonomies, the International Classification of Diseases (ICD) (www.who.int/classifications/icd/en/). The ICD classification is an international standard diagnostic classification for all general epidemiological as well as healthcare management purposes as it provides codes to classify diseases and a wide variety of signs, symptoms, complaints, abnormal findings, social parameters and external causes of diseases or injuries.

✦ The ATC system (www.whocc.no/atcddd/). The Anatomical Therapeutic Chemical (ATC) system is a system for classification of medicinal supplies according to their primary purpose and to the type of organ or system on which they aim to act and their chemical, therapeutic and pharmacological properties. It provides a global standard for classifying medical supplies and serves as a tool for drug utilisation research.

✦ The SNOMED CT system (www.snomed.org). The SNOMED (Systematized Nomenclature of Medicine) is a system of standardized medical terminology developed by the College of American Pathologists (CAP). According to the snomed organisation, their focus is to deal with a "comprehensive and precise clinical reference terminology that provides unsurpassed clinical content and expressivity for clinical documentation and reporting, and it allows a consistent way to index, store, retrieve, and aggregate clinical data". Nonetheless, in the health care sector there are also numerous interoperability problems to be resolved relevant to ontology. The VITA Nova project is focusing on the patient process, as this study does, as it includes the communication between the healthcare providers and healthcare units, thus facilitating the ontology of the patient flow process. The goals of the VITA Nova project are to develop a methodology to investigate the potential of an IT architecture based on process manager technology. As healthcare is functionally organised into primary care units, hospitals, and tertiary healthcare units many islands of information exist. More precisely, these information systems established at each healthcare level are characterised by the fact that they:

✦ support single organisational functions very well, but with little adaptation to a process oriented way of viewing things, i.e. where the intra- and inter-organisational processes can be efficiently co-ordinated much like the processes exhibited in the next chapter.

✦ are using different software and hardware platforms.

In this context interoperability problems in terms of coordinating the different cross functional processes are evident. The healthcare process is an order of activities or tasks, which are performed by human actors based on action rules, decided by the healthcare units. A new type of process-oriented, integration architectures has been developed by means of what may be referred to as process manager, which closely reflect the business processes. These are software devices that visualise the integration by means of graphical and easy to understand process models that facilitate management and monitoring of the processes based on their process models provided. Thus the communication between different healthcare units can be harmonised (Wangler,et al., 2003). The VITA Nova project will offer important insights concerning healthcare processes, and the potential benefits of using process manager technology for systems integration, for facilitating data transfer between healthcare stakeholders for the patient process in general. Therefore, although this effort is not directly relevant to the nature of this study as explained in the next section, this ontological healthcare project could fully cover interoperability issues relevant to the D-organisational level of this study.

Closing, there are also several other methodologies for evolving and merging ontologies which are not directly relevant to the nature of this study and currently are not fully implemented in the healthcare sector. The general logic enabled Formal Concept Analysis (FCA) approach for managing patient record instances is a conceptual model using a web ontology modelling language, DAML+OIL treating patient records as instances with regard to the ontology (Baader, et. al., 2003), or multiple ontology data integration systems like AQUA (Compatangelo and Meisel, 2003), that mediates between given queries and a set of resources, based on meta ontology methodologies are relevant important ontological efforts, although they are outside the scope of this problem domain. This section limits the presentation of the ontological scope of this paper to the methodologies used only for ontology development and not to efforts indirectly relevant to the D-organisational level of this study's ontology. On the other hand, the B and I-organisational levels of this study's enterprise ontology are going to be explicitly analysed and presented in the next chapter.

4.4 The Nature of the Framework under Study

The framework under study is a conceptually based OS concerning value-added services oriented towards patient needs, like information support services in decision-making. Based on the WB and the value chain managerial approaches which are fully supported by the enterprise ontology the patient flow process is devised for primary and secondary activities or processes. All processes are considered and designed cross functionally at ontological (B-organisational level) and informational (I-organisational level). Primary activities are characterised as those that are necessary for the organisational operation. Lack of any of the primary activities in the value chain model of an organisation will result to serious problems (Hammel, 2000). For example in a patient-oriented flow, lack of patient-oriented inflow process due to poor performance measurements will result in a substandard patient-oriented flow. Primary activities or processes can be divided in three categories directly relevant to the three healthcare levels. Primary activities are considered as being those regarding the patient inflow, treatment circle and the patient outflow through the hospital's environment. These activities integrate all levels of the health care system. They are directly relevant to the patient flow as sub-processes that accumulate results relevant to pre-hospital, hospital and post-hospital interventions. The next chapter will introduce the ontological core sub-processes, transactions and activities that will be assisted by the data-logical and info-logical level from the performance measurements included in the supporting information system. The focus of the ontological level analysis is placed in the core transactions and activities as they are designed to add the highest possible value to this study's aim and objectives.

On the other hand, secondary activities are supporting activities. They could be a part of the primary activities, as such activities assist the organisation in tactical management. Secondary activities are the activities concerning the basic information infrastructure (e.g., model documentation) that is necessary to perform the primary activities at the ontological level efficiently, and effectively. An organisational infrastructure is defined as the sum of all tangible and intangible resources that are used to complete a specific framework.

Secondary activities consist of the general data administration practices, human resource management and information environment. These activities can be analysed in relation to sets of value activities which are the transactions. The organisational theorem of enterprise ontology adds value to the secondary activities at I-organisational level (info-logical) and D-organisational level (data-logical) as it can improve the quality and quantity of their information. The secondary activities are not adding value for the patient unless the primary activities are designed in a patient-oriented way. The primary activities which this study analyses and redesigns are expressed organisationally through the B-level (ontological) to add patient value to the structured framework of the patient-oriented flow. Figure 4.1 exhibits this basic information infrastructure for a patient-oriented management framework. The domain under consideration, based on the organisational theorem of enterprise ontology, relates to the technology environment as it analyses discrete activities that include design, feature design, field testing process engineering and technology and system selection.

The patient and non-patient or rather healthcare-oriented parameters that are considered for the novel framework (OS) are presented, based on differences concerning patient value created that is relevant to primary and secondary activities which directly influence the patient flow.

4.4.1 Primary activities differences

A major difference in philosophy, and thus operational strategy, between patient-oriented and health care oriented services is the operational focus that is placed on the downstream activities of a healthcare organisation's value chain. Downstream activities are characterised as those that focus on the demand side of the value chain of activities that is related to the patient's needs and characteristics. For example activities relevant to patient inflow or patient outflow within the different levels of the system as well as the necessary examinations for such flow are directly relevant to the patient value-added. These activities include maximum interference between the healthcare model and the patient's needs for proper treatment and they are considered core activities for a patient-oriented flow redesign. There are also the upstream activities that mainly focus on the supply side of the value chain of activities, which is the set of hospital resources (beds, medicines etc.) which will also be considered in this flow. They are also necessary for the patient flow, and thus they will hold a measure weight in this ontology-based framework.

Another core difference between patient and non-patient orientation, in contemporary management, is activity-based orientation. An activity-based model is one that initiates action based on events that have occurred due to external factors. In this study's model, a series of business rules highlight the initiator, the recipient of the healthcare act and the alternative paths considered based on events occurred. An external factor is considered a medical exam that shows an unexpected result. Based on this study's organisational concept the patient is allowed ad hoc communication with the service provider in decision-making based on contemporary data (medical exams) as well as a possible recent EPR record that is requested through the process designed.

In a non-patient-oriented model, although it possesses certain activity-based parameters, the clinician would have to offer the patient services based on available healthcare relevant information and healthcare resources. Thus, the healthcare flow will not be easily rerouted due to any new activity that occurred.

Financially, adopting an activity-based model, activity-based cost accounting principles could be considered in this novel ontology-based framework. Thus, it is fair and possible to measure the real, but most of all necessary, cost that has to be paid based on the Activity-based Unit (ABU) (Helfert, 1991). The activity-based unit measures the number of activities performed in a specific time frame for each performing actor. The activity-based model that was analysed in depth earlier in this study acts as a catalyst towards the patient-oriented performance nature of this flow process.

The analysis of the core downstream activities that relate to patient management will assist in achieving better process performance without any major structural changes to the upstream activities at this point. In the future, once the core downstream ontological transactions are working then necessary changes will occur for the upstream activities. The reason is that the nature of the patient needs, as they will be defined by the downstream framework operation, will demand structural changes for the rest of the primary and secondary activities, especially for the primary upstream activities that entail the management of the healthcare information and data infrastructure of the value chain. This is why the term redesigning rather than reengineering is used for the framework's nature of this study.

4.4.2 Secondary Activity Differences

A secondary activity, as exhibited in chapter three (figure 3.6) is the information technology. A major advantage of ontology, between patient-oriented and non patient-oriented systems, regards their information infrastructure. All pieces of information focus on the patient awareness as he /she is the central actor of this flow. The nature of the enterprise ontological domain used in this system encompasses classes and class hierarchies that could successfully define the patient-oriented concept and its principles considered in this study. For example, the definition of the ontological act could be considered friendly to an activity-based financial system, the definition of entities which will be primarily the patients as well as their roles, participation, act relationship and role link efficiently differ structurally from the previous healthcare information models. The ontology domain has been used extensively so far in relation to the patient processes but not for this study's aim and objectives.

Another important ontology advantage, at secondary activity level, that exists between the models is included in the following approach example that will be based on the enterprise ontology, data-logical as well as info-logical infrastructure. In a patient-oriented approach when a patient enters the OS, with the use of EPR, the information will primarily focus on the patient (entity) record parameters. Based on the patient entity, the acts (activity-based system) that will follow will hierarchically allocate the entity to the proper healthcare resources. Based on these ontological principles this novel healthcare framework could assist in redesigning tangible resources to play a secondary role in the patient's decision-making process.

In the absence of an ontological framework, in a non-patient-oriented approach, when the patient enters the system with a specific diagnosis the information will primarily focus on the physical resources available relative to the patient's diagnosis. Based on this diagnosis the decision-making process will start implementing the necessary actions taking into consideration the most common patient flow route using the system's choices. Correct diagnosis is a key transaction in patient treatment (Schiff and Bates, 2010). Thus, the nature of the whole system is not patient focused. The reason is that often the necessary examination occurs in facilities where medical resources are available, so if there are no medical resources available minimal or no examination occurs. Therefore, the diagnosis is often not performed based on this study's concept. Thus, the actor "patient" receives treatment based on the diagnosis provided, but he or she receives not the best possible treatment, as medical resources availability limit actors' choices. From a financial perspective in such a non-patient approach, few aware patients will agree to pay for activities that they deem only to be of minimum value for them. What follows is the core design of the patient-oriented flow concept as the nature of this study towards implementing a patient-oriented framework emphasises in the diagnosis process:

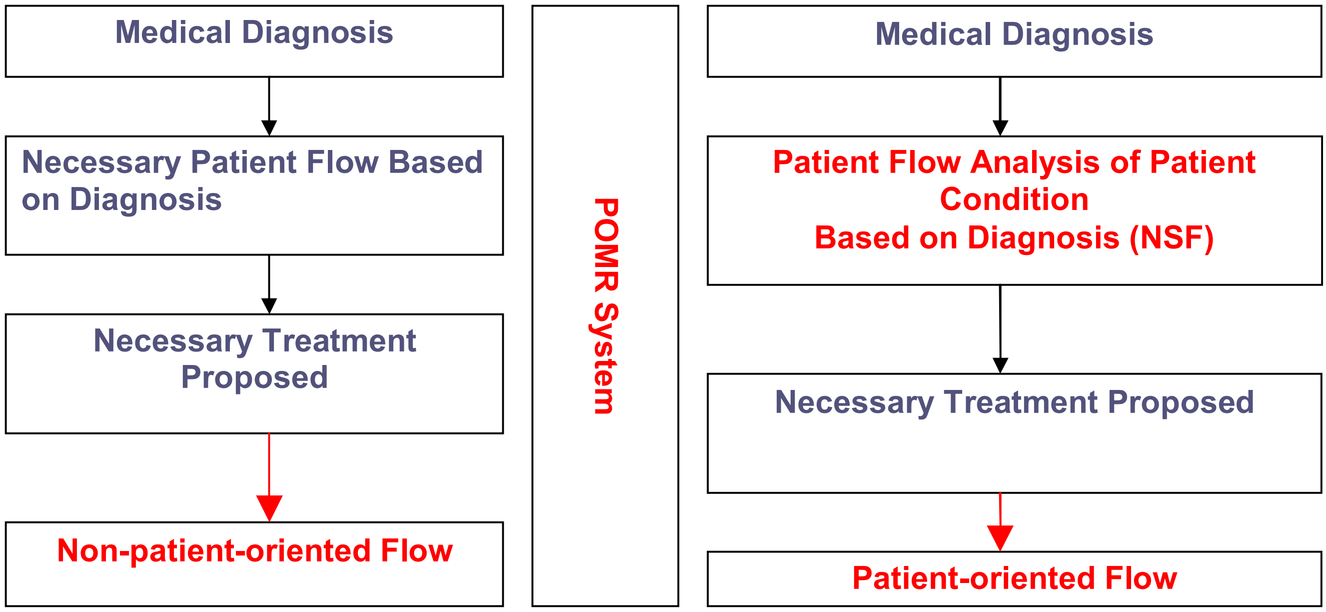


Figure 4.1: Patient-oriented Flow versus Non-patient-oriented Flow

Finally an example that defines the nature of this study's healthcare system at all levels of the organisational theorem of enterprise ontology is the following:

A patient enters the system. The patient profile encompasses the following needs:

1. Heart surgery (treatment request)
2. Best surgery team (efficiency request)
3. Minimum waiting time (accessibility request)
4. Best result possible (effectiveness request)

A patient-oriented approach will focus on the patient's needs and based on those will make the necessary decisions. A non-patient approach will focus on the primary treatment request of the patient (the heart problems) and based on this need it will allocate the patient according to the availability of heart clinic resources. The first issue here is the equality parameter that is not taken for granted, as a lack of clinic availability may result in maximum waiting time and thus lack of patient choices. The second issue is the efficiency. In this case, the patient receives less than expected human and administrative service, and the entity needs are not valued accordingly. The effectiveness is also in doubt, as the availability parameter does not necessarily assure best quality patient treatment. Lack of either specific best medical performance measures or simply lack of resources availability may result in a poor patient choice. The reason is that the selection process for best clinic is carried out either geographically or based on availability of the national hospitals' emergency system design or both, it is not based on the patient's demand.

In conclusion, the concept of a patient-oriented patient flow refers to the flow that primarily focuses on the patient entity as its centre and initiates acts based on this patient entity. The contemporary healthcare-oriented approach of patient flow focuses on healthcare resource parameters of the entity (medical conditions, healthcare operators etc.) and initiates actions based on these parameters. The nature of this framework study proposes that, for patient-oriented measures to be fully integrated into ontology-based patient flow, healthcare resources availability should be considered as a necessary factor. Assuming such a factor, managerial issues concerning communication and organisation of the system's universe and its interaction with the object receive the major attention. Thus, as presented earlier in this chapter, there are several approaches in the literature for ontology development. Each approach has its own concept and methodology. On the other hand, ontologies could be delivered through the combination of certain methodologies and one tailored for the specific system development situation as ontological methodologies are an aid not a dogma.

4.5 The Adopted Dietz Redesign Methodology.

The DEMO methodology was selected for the aim of this study, since based on enterprise multilayer structure, it develops a framework that bridges mostly semantic gaps between technical and social issues, which are very important according to the literature review for the nature of this study. So, the next step in developing the system is to answer several basic questions at a higher level. In this phase, a business activity model is developed. The term "model" is used to define, at the ontological level, the prototype of the patient-oriented model of this study. It is also a supporting information system to this model of a world or a state model that assists the framework's concept at info-logical and data-logical level. The exact definition for the purpose of the enterprise ontology and engineering used in chapter three of this study should pursue the following parameters (Rosemann, Wyssusek, 2005):

- ✦ An object is either a factual item or a construct and none is both.

- A factual object is either linguistic or extra linguistic and none is both.
- A linguistic object is either a term or an expression or a whole language.
- A construct is either a confirmation or a propositional function or a set off either.

The following "semiotic triangle" in Figure 4.2, based on Bunge's ontology (Bunge, 1977) which is direct predecessor of the enterprise ontology, distinguishes and clarifies the above parameters.

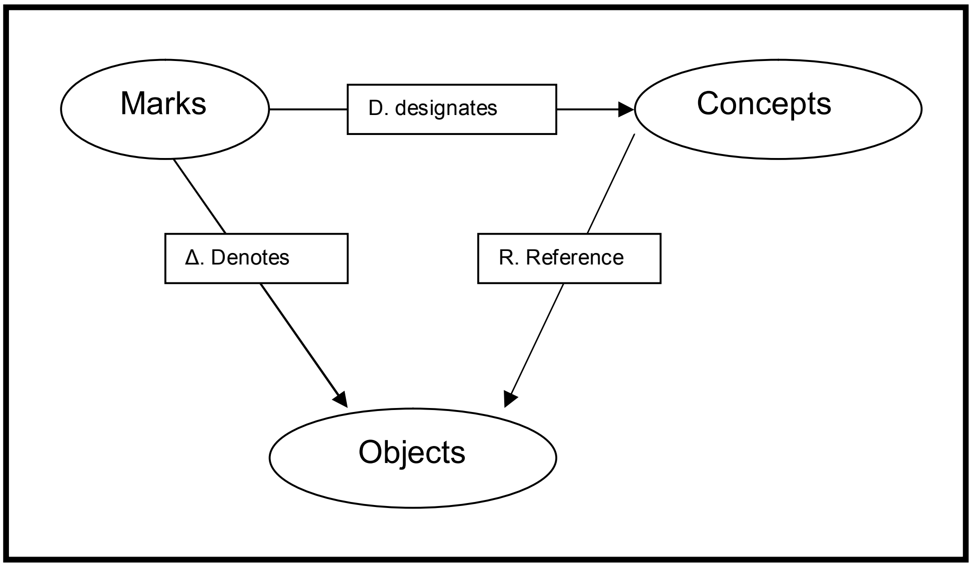


Figure 4.2: Bunge's "Semiotic Triangle" Model

According to the "Semiotic triangle" marks are signs that designate (D) constructs or concepts that refer (R) to objects. Once designation (D) and reference (R) are given, then a denotation (Δ) can be constructed as the relational product of D and R (Rosemann and Wyssusek, 2005). This model is the state model of the enterprise ontology. This model is directly relevant to the ontological model under development for the patient-oriented healthcare mark. At this point any necessary new features for the system to encompass are also considered. Then, according to reengineering methodology, which is also directly relevant to enterprise ontology the current processing is analysed to understand the structural properties of each class and the information flow of the services provided. The ideal processing produced should possess the properties of environment, structure, production and composition. Bunge's triangle is very close to the constructional decomposition of the White Box model that expresses the ideal processing in an ontological world. According to Bunge’s definition, the enterprise or the organisation is a system that could be analysed based on ontological concepts like the semiotic triangle and ontology parallelogram that are tools used to define such concepts. Through these tools, the enterprise ontology disciplines are being introduced to engineering methods. The organisation definition is of importance to this discipline, as it is the kernel of the system to be designed. The organisation is defined as a thing that encompasses the following properties:

4.5.1 Composition (PSI Theory)

Based on Ψ-theory (Performance in Social Interaction or the operation axiom) of enterprise ontology, a system is composed of elements (social, economic, technological) and actors that are subjects with particular roles. These actors are assigned to different worlds which are the coordination act world (C-world) and the production act world (P-world). The C-world is a world where the actors have the role of coordination. This means that, based on a list (*agendum*) of c-facts (things to do), the actor has to coordinate the completion of these things within a specific timeframe. Thus, these actors have the responsibility to complete a transaction by finishing these c-facts. Other actors, as well, based on *action rules* could become involved in coordinating these c-facts upon request. Thus they all potentially coordinate to finish these c-facts through a series of acts called c-acts. There is also the P-world where the elements of the composition produce services that are delivered to the environment by an actor that has the competence or rather the ability to produce specific p-acts.

4.5.2. Boundary

The compositional nature of construction model as it clearly describes the external and internal environment and the actors within separates the system in to two subsets. The first is called the kernel and it is the organisation or the organisations that are clearly separated with a closed line frame called the boundary. This boundary separates the internal organisational parameters from the external second subset.

4.5.3 Structure

The construction model in this methodology describes a system's composition, environment and structure. This model thus perceives both internal and external organisational environment holistically, and it is referred to as the global construction model of an organisation. In this model, actors influence each other and these interactions produce several transactions.

The objective here is to develop a basic visual to understand the current problems aside from the fact that current processing often could not be developed according to enterprise ontology properties introduced in this study. Mapping the system process, however, will help in assessing the necessary data currently supplied for patient satisfaction (Matthew and Clarke 2004). The concrete visual is a model of the conceptual system called implementation and will be presented in the next two chapters. At this point, as the organisation definition is clear and with the assistance of the literature review chapter where all the necessary healthcare actors and organisation definitions are defined, the next step is to introduce the ontological concept mapping and definitions of the patient-oriented flow and patient-oriented healthcare. The use of concept mapping, based on the ontological parallelogram, contributes to the identification of the dimensions of the patient orientated healthcare concept (Southern, at. al., 2002). The domain or universe of discourse of this study's ontological model is the patient flow. Thus based on Wolstenholme's patient flow analysis (Wolstenholme, 1999) as well as the contemporary healthcare flow in Greece a dichotomy of the subject and the object world according to enterprise ontology has to be carried out as follows:

4.5.4 Object World

The object is an identifiable individual thing but it can also be abstract like the patient's medical condition. This abstract object of this study is referred to as "patient condition," which is denoted by the objective "patient-oriented healthcare sign". As an abstract object, the "patient condition" should be an observable measurable thing, using the patient-oriented measurement's framework to explicitly evaluate the concept of a "patient-oriented healthcare" sign.

The "elective patient" term refers to patients that can communicate about their condition status, and they could be referred to as subjects or actors. The actor "elective patient" entering the healthcare system possesses zero knowledge regarding his/her healthcare status, as the "patient condition" object is directly dependent on the subject world. On the other hand, although non-elective patients are subjects due to an emergency situation, they are not able to communicate directly regarding their treatment process with the subjective world. It is important for the aim of this study to distinguish between elective and non-elective patients. Both conditions for elective and non-elective patients are in subject status, but elective patients are those that are in a mental position, as subjects, to decide based on direct information from the subjective world, which includes the supporting information system, if they will proceed with an indicated flow process path or an alternative path or exit the system. Such kinds of actions are rather relevant to their democratic right to act as subjects. As elective actors, these subjects are in position to refuse service or even exit the healthcare system. So this model's object which is the "patient condition" could receive patient-oriented quality service based on collection of measures value based on the supporting interactive information system. Thus, the object of the "patient condition" is measured in relation to the desirable patient value-added service level referred to in the concept of this study.

For example, when a processes step of a core transaction, that of diagnosis, is performed then the subject thing "patient" could change transaction status and proceed with the next transaction of the flow. This means that the actor "patient" will be diagnosed for his/her condition and will be informed about the possible alternative decisions from the other system's actors according to this study's framework. As a result, the actors "patients" are in a condition to proceed with autonomy within the healthcare system as they are able to decide regarding their "patient condition's" treatment from actions which are initiated from the subject world. Although "patients" are not experts in healthcare, as physical entities once they posses the necessary information from other actors in the system they could decide alternative flow paths, exit the system or even challenge actor's decisions. Thus, they are considered composite actors as social subjects that possess the right to decide regarding their flow management as well as their medical condition. Thus, the scope of this study, relating to the objective world, is to define, based on this study's ontological structure and objective measures, the necessary acts, transactions and sub-processes for a patient-oriented condition management during the patient flow process. Such a value-added service is presented in Table 6.4.

A more practical, good example of such a value-added service use is a person that feels dizzy and calls the 1535 line for a GP appointment. In Greece this appointment for the public healthcare sector could take a month for a pathologist or up to four months for a cardiologist (Papanikolaou and Ntani, 2008). In such a situation, it is important to measure the result of damage diagnosed in the patient's medical condition in the case that this disease was serious. The problem in this example is that the subject could have received services from the best doctor but from a delayed diagnostic process delivered by the subject world. As a result, a life threatening "patient condition" diagnosed late could cost the patient's life. Thus, the patient-oriented healthcare flow is focusing on patient's rights in seeking treatment through timely, proper and well communicated healthcare services (Sure, Tempich and Vrandecic, 2006). Such services assume that doctors or other healthcare stakeholders are performing, efficiently or less efficiently, actions in the subjective world based on sincere concern for the patient.

4.5.5 Subject World

The subjects (e.g., doctors) are the entities that are responsible for the service delivered. If the supporting information system encompasses specific measures for the object's instances ("patient condition"), then timely information relative to the service provided will allow patients to make an informed decision relative to their flow path options. The subject possesses power over the object within the healthcare ontological framework. The model's supporting information system will measure the results from ontological model actions in regard to the implementation of this study.

Using the Xemod software tool developed in 2008, enterprise ontology transcends the limitations of OWSL, DOGMA and GOL. Although the concept and application of the state model, which is based on the Bunge's semiotic triangle (see Figure 4.2 Bunge's "Semiotic Triangle" Model), was initially delivered on OWSL (World Ontology Specification Language). This software tool assists in creating methodology's models like the state model, process model and action model all of which will be analytically presented in the next chapters based on DEMO methodology.

There are however, two distinct types of conceptual models in ontology which formed the basis for the different orientation of the ontology methodologies presented earlier in this chapter. These two conceptual models are the White Box (WB) and the Black Box (BB). The WB model is the definition of the using system according to ontology. It captures the construction and operation of the system, leaving abstract implementation details abstract. It is good for understanding building, or changing a system. No matter how someone is going to constructionally decompose the contemporary healthcare system, the following facilities are going to be present:

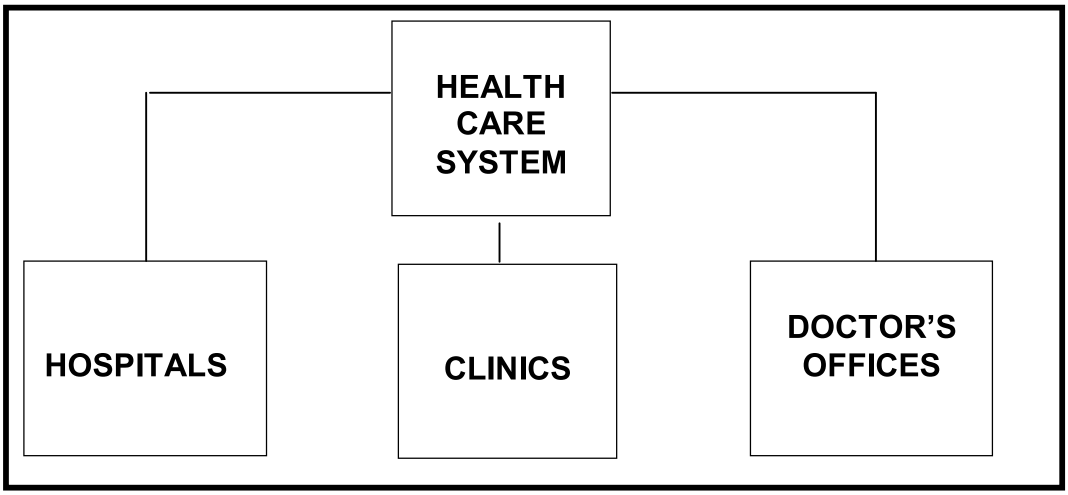


Figure 4.3: White Box Model Constructional Decomposition

In a WB model, as the figure shows there is only one technique to compose the elements of the class. Any other way of composing these elements would not give us the same using system. On the other hand, a BB example models for the dynamic nature of this study, as the patient flow involves patients passing from one healthcare level to the next. Thus, the BB discusses the patients in terms of these healthcare process levels, which are used in order to receive treatment. Thus the BB model is useful for constructing “A supporting information system” for measuring the action results of the patient flow model. As the WB defines the patient flow itself, analysed from the construction perspective, it does not understand the exact patient flow process. The BB model is a conceptual system that is not relevant for the functional construction, design and operation of the concrete model that it functionally analyses. It is good for evaluating and controlling this study's model. The BB model cannot capture this concept and the specific acts required for patient-oriented flow transactions which are necessary for its proper construction. Although it looks like the BB model is the only appropriate one for such a supporting information measurement system, the WB will assist in introducing the exact transaction redesign necessary to measure this flow according to its key success factors, or rather, activities' results. Thus, the WB will be followed through Bunge's "semiotic triangle" and ontological parallelogram for the enterprise ontology concept introduced later in this study. The BB model expresses the teleological school of thought presenting the interaction between internal and external system variables.

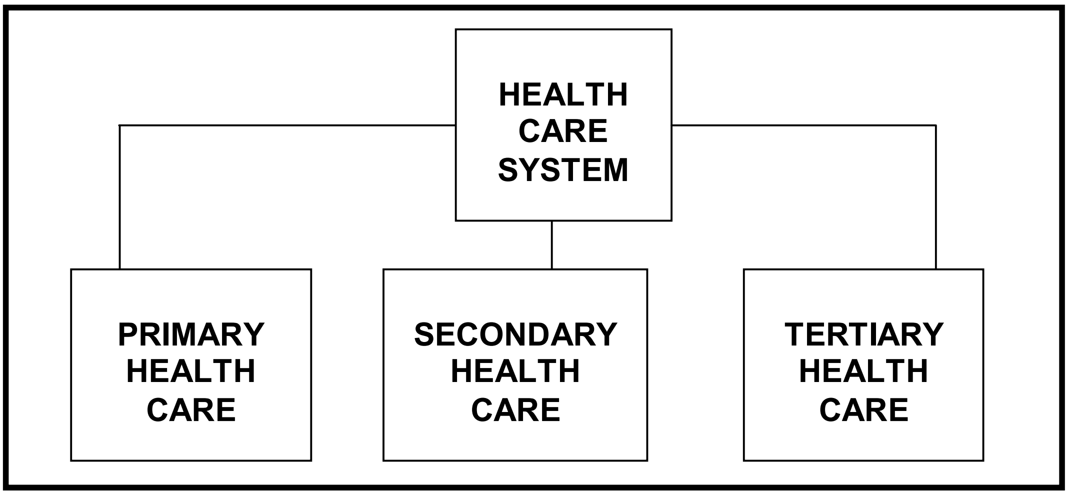


Figure 4.4: Black Box Model Functional Decomposition

The BB model is also flexible to patient's demands as the patient's input and output values of the supporting information system derive from a patient-oriented performance model and thus both of them form the necessary framework for this study's concept implementation. Through changing the values of the input variables (e.g.,. the results of a medical test or measure) the patient could change the output variables (e.g.,. the patient flow direction). Theoretically this function of changing input output variables through a transfer function is a mathematical formula. In practice, however, there are many parameters to be examined, so the notion of this function is loosely defined and that is why national healthcare systems are experiencing great difficulty in establishing cohesive health measurements and standards, as the evaluation of quality is subjective in regard to clinical measures.

Then according to DEMO implementation technological tools (e.g. CLIPS) are assigned to the systems elements so that it can be put into operation. In every redesign process based on methods engineering and BPM oriented principles analysed through this study's DEMO methodology there are two systems involved:

- ✦ The using system (US);
- ✦ The object system (OS).

The process of constructing a flow is called engineering and delivers a US. The process of reconstructing this flow of the US starting from the ontological model that represents the US is called reengineering and delivers the OS. So, the following figure according to Dietz (1999) explains the designing and redesigning methodology of the enterprise ontology through DEMO and its implementation with CLIPS technology:

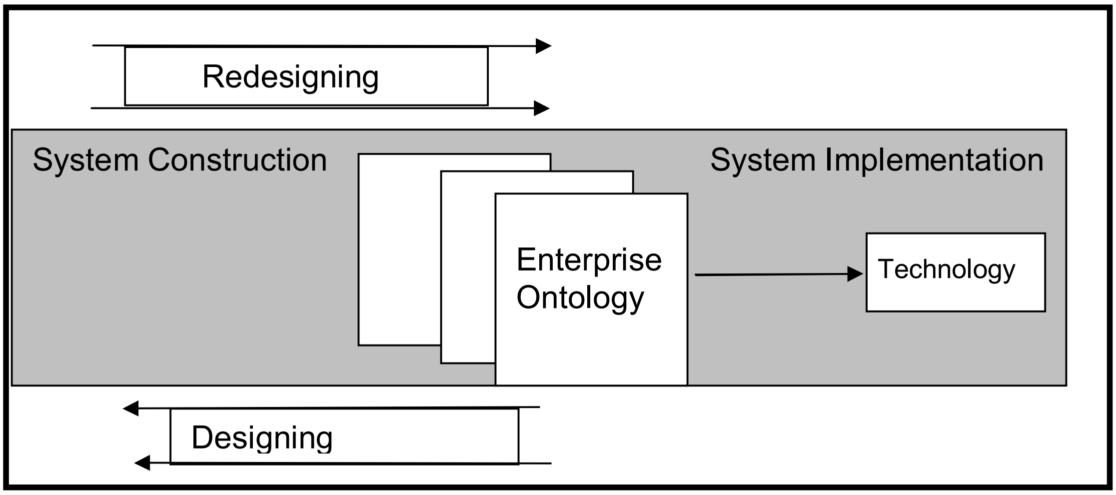


Figure 4.5: The Enterprise Ontology Role in the Designing of a System

Based on Dietz's enterprise ontology, this study implements a patient-oriented framework following the methodology steps according to the table 4.1:

1. Requirement analysis for the US with WB model
2. Structural decomposition of the US with the WB model
3. Identification of the redesigning requirements (BB Model input)
4. Redesigning of the specifications of the results and measures function (BB Model output)
5. Devising Specification of the OS with the WB model
6. Redesigning and Implementation of the OS with CLIPS technology

Table 4.1The Enterprise Redesigning Methodology Steps (Dietz, 2006)

Thus, based on this unique system notion, the above redesign methodology and its supporting information system implementation with CLIPS technology will assist towards the aim of this study. The DEMO methodology steps including the relevant tools for the OS design (see Table 3.0) are introduced at step 6 of the above Table 4.1. This Table’s methodology steps adopted are graphically exhibited in the figure 4.6:

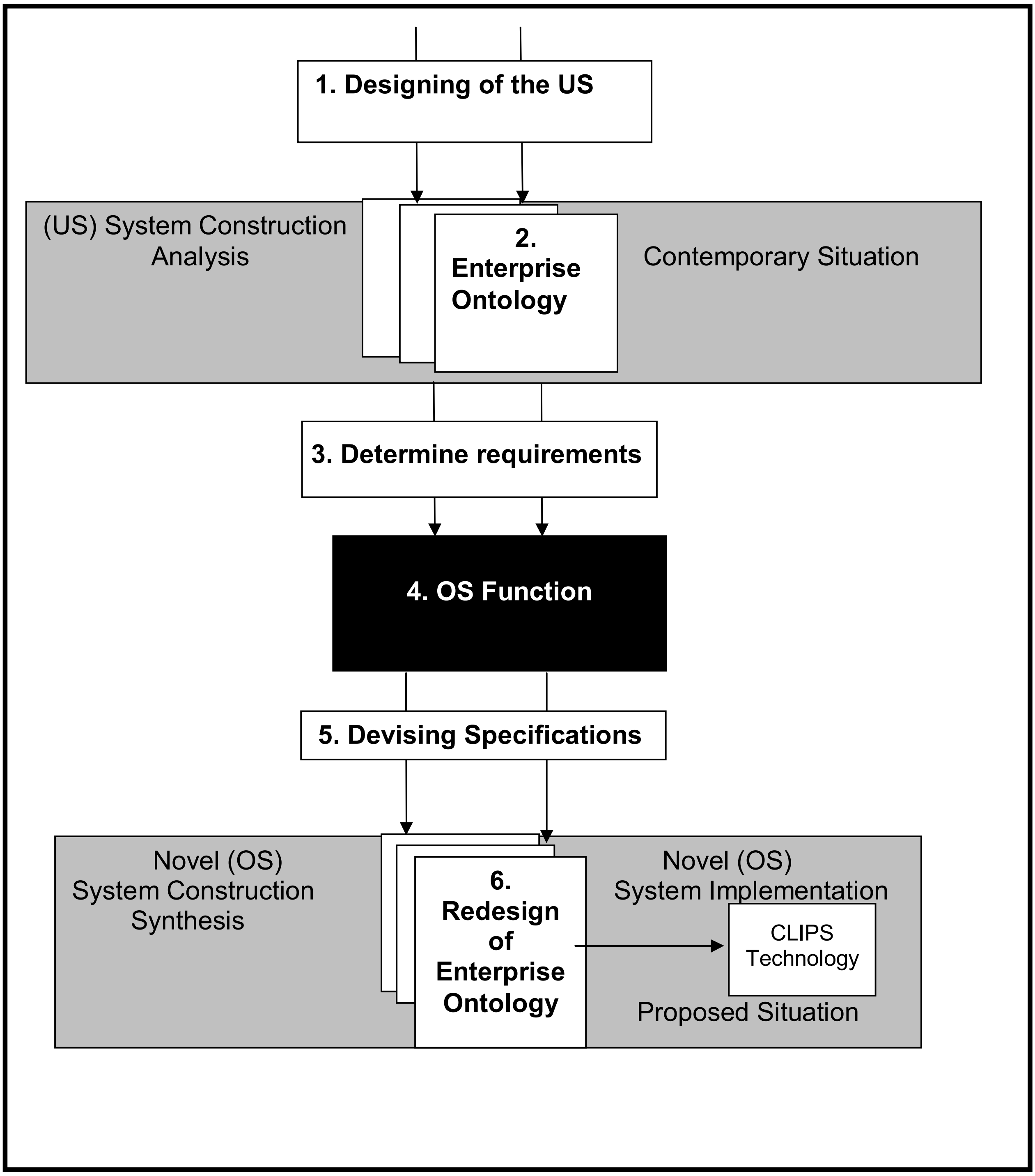


Figure 4.6: The Adopted Redesign Methodology

4.6 Summary

These terms and methodology steps described above cover proper care and treatment of patients in transactions like diagnosis, surgery, treatment paths selection and medication. They also cover terms used for healthcare administration, which are based on primary and secondary evidence from the patient flow model. By using this terminology, processes and rules are embedded in computer applications, and clinical stakeholders could record patient-oriented processes and information in a consistent manner. The Dietz enterprise ontology concepts, worlds and tools like the "semiotic triangle" (Bunge, 1977) as well as the ontological parallelogram (Dietz and Baris, 1999) are analysed in the next chapter in an effort to aid the recording of clinical data that can be communicated in a standard way between healthcare frameworks and individuals. Thus, the US design and the OS redesign are processes in which WB models are produced. Each one of them derives from the previous one. In modern ontology like Dietz enterprise ontology a results measurable goal is always in order in addition to any ontology's original meaning. Modern ontology does not only serve as a basis for a common understanding for frameworks development but also for terminologies, processes and concept domains among communities of people who may not know each other and who may have a diverse cultural background. So, as long as conceptualisation, communication and the essence of construction and operation need to be understood and measured by people, ontology motivates the implementation of this study's concept.

Closing, this study's domain requires focus on the WB model but it will also needs the properties of the supporting information system's BB model for measuring the ontology flow results in order to deliver a patient-oriented quality framework. The WB model is used, as the patient is not the ultimate actor of the healthcare services provided but rather the recipient of them. In a BB model the patient's perspective has to be the dominant one and thus the information system assists in the performance results flow measurements.

According to the hierarchy of the methodology steps of Table 4.1 and Figure 4.6 the next chapter will determine and analyse the systems requirements and needs. Such needs and requirements are necessary in order to design and redesign and then implement the patient flow model and its OS based on enterprise ontology and CLIPS technology.

Chapter 5 US Analysis and Needs Assessment: DEMO

5.1 Introduction

The selected ontology systems analysis and design process was described in the previous chapter and also briefly presented in chapter three. This chapter proceeds with the analysis level implementing each part of the contemporary situation analysis and produces the necessary requirements. The role of this chapter's analysis is the division in the contemporary patient flow process into sub-processes and transactions in order to provide an understanding of the way the healthcare flow system currently behaves and assess the problem domain. This chapter concludes with the description and analysis of the current healthcare problems related to patient flow and proposes solutions.

5.2 Requirements Discovery

Early in this study, a survey was conducted and presented in chapter three in the northern part of Greece in order to approach the contemporary patient satisfaction level of the patient flow process primarily from the patient point of view. The literature review demonstrated similar orientation towards patient-oriented flow. The questionnaire results together with the interviews of healthcare stakeholders (all of them doctors) are used to describe the current situation. Various research methodologies have been developed in order to measure patient satisfaction, including interviews, focus groups and questionnaire surveys. It is not surprising that questionnaire surveys, especially when supported by interviews, became the most widely-used method of measuring patient satisfaction, as they are easy and cheap to implement (Papanikolaou and Ntani, 2008).

5.3 Fact Finding: The Background of the Current Situation

An initial questionnaire was delivered to patients who had recent experiences in the healthcare flow both in the private and public sector. The results, which were analysed in chapter three, showed that the satisfaction level of the patients in both private and public sector was low. The results of this analysis showed an indication of the satisfaction level in relation to the healthcare stakeholders services provided. Besides the unsatisfactory results from the initial patients' questionnaire, the difference between the public and private healthcare sector was obvious. It was also obvious that the doctors and the healthcare administrators were the major actors of the patient flow process. Thus, another questionnaire followed by interviews of the questionnaire respondents, which will be the doctors with managerial roles, will assist in describing the problematic level of satisfaction in most of the areas according to the questionnaire which was delivered to the patients. This questionnaire will assist in the description and analysis of the contemporary situation. This doctor's questionnaire and interviews will assist in describing the exact contemporary patient flow in both the private and public healthcare environment in an effort to map the flow and discover the problematic areas.

5.3.1 Questionnaire Delivery

For this reason, this second questionnaire relevant to the patient flow processes and actions was offered in an effort to further comprehend from the system actors' point of view the technicalities and functions of the patient flow in northern Greece. Thus, appointments were arranged in an effort to receive primary information concerning the contemporary healthcare structure of the patient flow. The questionnaire was first delivered and a couple of days later the interview was conducted as a standard operating procedure for receiving the necessary information. The comprehensive nature of the questionnaire questions, due to the qualitative nature of this study's concept, was recorded by the researcher when the interviews were conducted. In these interviews usually three doctors were present in an effort to view a power point presentation (see Appendix 3), discuss and further comprehend the contemporary flow. These interviews had the nature of a workshop and they lasted approximately three hours each. Then the questionnaires were delivered by the respondents some on the spot and others were sent to the researcher's office. The anonymity of the respondents and their organisations was guaranteed for the purpose of avoiding any biased answers relevant to the questionnaires. The PP Presentation and questionnaire are attached in appendix 3.

5.3.2 Interviews with the Questionnaire Respondents

According to Kahn Davis and Kosenza (1988), the people selected to be a part of the sample should be interviewed in conference rooms or offices. All interviews with the doctors were implemented for the purpose of this study either at the interviewees' offices at the hospital or their private facilities. Such kinds of interviews, as well as the ones presented in chapter three, followed the completion of the questionnaires. The interviewees thus had the opportunity to express their expert opinion based on the questionnaire delivered. As mentioned in the NHS report (2001), it is very difficult for doctors and clinical staff to admit their errors, especially those relevant to patient safety and patient experience. According to the researcher's experience, if the same sample were to be observed during their work in a hospital environment one could have a more precise picture of the problem researched. Accurate information is very difficult to obtain with a formal approach, although anonymity and confidentiality are guaranteed.

As a result of the piloting procedure, some questions were eliminated and some were modified in order to make them easier for the respondents to understand.

An appointment was arranged with the doctors all of them whom held top managerial positions in their healthcare organisations. All of them showed interest in the patient-oriented flow concept. They were also informed regarding and presented with the patient questionnaire results in an effort to describe the problematic areas regarding qualitative issues relevant to the patient flow. Then, as they did not have any technical knowledge regarding ontologies, the enterprise ontology concept and its methodology was briefly explained in an effort to help them further understand the nature of the interview. As a result, they were clear about the concept of a patient-oriented flow of this study. The support of the top management and the system users is always essential for the system's successful implementation (Drucker, 1995). In the Greek healthcare sector, the aim is the quality of the services, and at the same time, a decision support tool for budget cuts. This was the perspective for all of the interviews and questionnaire results presented in the following sections.

5.3.3 Data Analysis

Once the questionnaire was collected, the approach used for data analysis was Confirmatory Data Analysis (CDA) unlike the patient questionnaire presented in chapter two. The major reason is that the aim of this questionnaire is to confirm first-hand the patient flow in the Greek healthcare environment. CDA should also be used with numerical statistics that complete the statistical analysis. The CDA has the strength of the evidence found via the direct interview implemented for the purpose of this questionnaire. This questionnaire evidence is strengthened through the literature review of this study, and it will be evaluated in latter chapters.

<u>Phase 1: Data Preparation</u>

With the similar methodology of confirmatory data analysis, this section concerns the data transformation to numbers which are necessary for confirmation and statistical analysis. So the coding of data, once all questions which had misleading answers were removed, is the following:

For the yes and no answers, yes will count for one (Yes=1) and no will count for zero (No=0). For the explanatory questions that actually use the term “describe” or like question Part B question 6, there is no number association. The rest of the questions like Part B questions 7, 8 and Part A question 5 will be coded on the Likert scale the same as the initial patient questionnaire very important or yes often counts for 4 not important or no counts for 1. No counts for 1 and not for 0 as few respondents (13% of the population) have different views concerning patient satisfaction.

When interviewed, they claimed, contrary to the nature of this study, that patient satisfaction will come automatically once the healthcare resources are organised properly. Finally, for part C the quantitative and differentiation questions the following scale applies:

1. For the demographic data quantitative questions, question number 1 for more than 1000 counts for 5 and for less than 200 counts 1. For question 2, more than 200 counts for 5 and less than 50 counts for 1.

2. For the differentiation question, private healthcare is represented with 2 and public with 1. The same worksheet as the patient questionnaire was used, which is the SPSS worksheet. In total there were 16 questionnaires collected and 17 questions were analysed.

Phase 2: Data Presentation

The first part of the questionnaire contains questions relevant to the patient flow structural issues. For this part in question 1, none of the respondents had any computerised model that the healthcare organisation follows in order to assure the quality of the patient flow process. In question 2, there is also no specific manual that maps the patient flow structure, and thus the hierarchy of the transactions that have to be followed. In question number 3, there is also no computerised supporting system or module that evaluates the quality of the patient flow in their healthcare organisations. Of course this answer was expected, as the previous two underscore the lack of any formal healthcare structure in quality management, electronic or other. On question 4 that is relevant to the kind of quality evaluation of the services provided, most of the respondents admitted that their organisation has a quality form which is given to patients. As they rarely hear the results, they are not sure that all patients are receiving a quality evaluation form due to lack of such a quality control process; follow up question 5 score was low (2.428 points out of 4 points) . So, most of the respondents are rarely informed about the results of the patient experience during their hospitalization. Informally, however, according to question 6, they hear complaints mostly relevant to bed and room availability.

The next part of the questionnaire concerns the computing skills of the respondents. In question 1, 65% of the respondents were computer literate. In question 2, which is relevant to using DSS tools, the percent of the respondents that use such kinds of tools is even lower (59%).

Regarding the respondents familiarity with ERP systems in question 3, 89% of them were aware of the ERP systems and their usage, as either it was installed in their hospitals or they were examining its potential implementation.

In question 4, which refers to performance quality measures, 41% of them were aware of such practices but not systematically. In question number 5, all of the respondents answered “yes,” although they did claim specific conditions which must be satisfied for their answer. Such conditions were explained when further discussions were in order during the respondents’ interviews. In question number 6, they were all familiar with the concept of ontology due to their familiarity with the Aristotelian term “ον”. They were not, however, familiar with its implementation in AI.
Finally, in questions 7 and 8 relating to patient satisfaction and treatment, both were answered highly positively. In question 7, a 3.071 average score out of 4 underscores the respondents’ interest in patient satisfaction. In question 8, they scored even higher with an average of 3.125 which shows that Greek healthcare stakeholders care a great deal about their patients’ treatment.

Finally, Part C of the questionnaire reviewed the demographic data of the respondents. Regarding the number of beds, 2.6% of them had more than 1000. Then, 54.4% of them were in the range of less than 200, in the scale of 500-200 beds were 22.3 and 18.4% were in the scale of 500-700. Finally in the range of 1000-700 there were 2,3%. For the number of doctors question 2, 8,2% of the hospitals had more than 200 doctors, 32.8% had 100-200, 23.1%of them 100-50 and finally 35.9% had fewer than 50 doctors. In regard to services, 53% of the respondents were providing services in private hospitals and 47%of them were in the public sector.

Phase 3: Inference Drawing

Following the data analysis, examination of necessary evidence for the rejection or support of certain hypotheses is in order. Based on the knowledge gained from the questionnaire and interviews implementation, a logical but also apparent question is whether there is a difference between public and private hospitals. In other words, is there any evidence that the respondents’ answers were biased by their positions in the private or public healthcare sector? In order to test the questions’ independence the x2 independence test was implemented testing each question according to the 3rd question of the 3rd part of the questionnaire (public, private question).The hypotheses are the following:

H0: The results are independent, and there is no evidence to justify the difference.

H1: The results are not independent, and there is evidence to justify the difference.

The SPSS statistical software package was used in order to carry out this test. Thus, the result examinations provided evidence that there is a difference in question 5 from part B of the questionnaire and in question 3 from part C of the questionnaire. Thus, it is imperative to investigate on a case study level the private and the public hospitals in relation to the way that they efficiently monitor their patient flow structure.

5.4 Description of the Findings

The most important observation was that none of the participating healthcare organisations has any computerised quality assurance instrument of any kind. Actually, most of the doctors' interviewed said they had never heard of a performance measurement system for patient flow that is applicable in the contemporary Greek healthcare sector. Of course, all of them knew of ontology and its conceptual Aristotelian roots, but they did not know its artificial intelligence perspective. They were also all very interested in their patient satisfaction and treatment results. The description of the findings for elective patients considering the national idiosyncrasies of the Greek culture allows the reader to understand the current situation in Greece. It clarifies the principal reasons for the status of the healthcare-oriented focus, which is the current situation in Greece.

Based on the questionnaires that were implemented to identify the current patient satisfaction and treatment information as presented in chapter three and the findings of this doctors' questionnaire it is clear that the services are not built around patient needs. They are built around the healthcare system's necessary requirements for the system to operate.

On the other hand critical parameters, both in the private and public sector, aimed at improvement in future according to this study's research. Although the patient flow processes follow the same order both in the public and private sector, there are two differences according to the questionnaire findings between public and private healthcare. First, in the last question of the questionnaire, there are fewer doctors in private than in public healthcare, and, second, many public hospitals had installed an ERP system. Therefore, it is reasonable to investigate the effects that these differences have in the way that they perform their healthcare flow on a patient condition basis.

To deliver change based on any methodology, serious commitment is needed from all the participants. Personal traits and characteristics of the participants, as well as personality and values, are very important parameters. So, process steps declaring exact ontological transactions and their implementation are necessary to improve communication among the universes' actors. According to Protty, these processes' accumulated results should be embedded as patient held records in any hospital's EPR (Protty, 2006).

A set of important parameters that will guide this effort, as delivered in part b of this doctors' questionnaire, and must be solved at info-logical and data-logical level is that of systems interoperability. The definition of the interoperability contains the following characteristics (Pollack and Hodgson, 2004):

1. Systems may share information based on custom information bridges.
2. Some organisational systems remain autonomous.
3. Connectivity issues are not so strict.
4. Information processes are mapped rather than implemented.
5. Local data vocabularies are preferred.

Due to the dynamic nature of the patient flow, a high degree of interoperability according to the respondents at each healthcare level is initially required between different levels of healthcare as well as institutions. Ontology, however, will provide standard data vocabularies necessary for a future system's integration. According to the respondents, EPR in Greece is in its infancy, and it is very difficult to accomplish an integrated system throughout the country's NHS. Based on this study's secondary research and questionnaire, there are no applications of an electronic patient record or any specific interoperable information supporting electronic healthcare records as of 2010 among different hospitals. Although the kernel of the ontological model seems to be solely the hospital, the respondents consider the hospital as an extended organisation of the GP's office as well as the rehabilitation facilities. Currently, the national public healthcare policies demand such services within the general hospital facilities. Such an approach strengthens the parameter of the dynamic nature of the EPR. The findings also indicated that ontology standard data vocabularies and processes presented in this study could assist in establishing interoperability at the data-logical level. As a matter of fact, interesting issues relevant to Greek patient idiosyncrasies came to the researcher's attention and will be discussed in the further interview discussions section of this chapter. A further interview discussion with the doctors will assist in this ontological model's processes and transactions. It is also important to mention that, according to the researcher's observation in the hospitals visited, while making hospital rounds with doctors for the purpose of this study, these idiosyncrasies were verified ad hoc.

5.4.1 Case Study: Public Sector

None of the respondents, as was mentioned above, has any type of patient-oriented processes and evaluation measurements framework for that purpose. The majority of the doctors who also serve as general managers in their hospitals showed great interest in the patient-oriented concept of this study. They also were particularly interested in how such a system would improve the quality of healthcare. They all strongly agree that, if they had the chance to implement such a system structure based on ontologies, the healthcare environment of their organisations would be better. Specifically, they claimed that currently, as there are no systemic practices regarding the patient flow, several issues occur. Some of the most important are listed below:

1. Patients can not make appointments when they need them.
2. Patients can not have a clear picture of their treatment process.
3. Patients can not be convinced that they received a satisfactorily level of healthcare services, as there is no data indicating such an issue.

4. Patient treatment processes could not be efficiently managed.

They were also interested in the proposed patient-oriented framework and its methodology. They claimed that this structural empowerment of the patient in order to make the right decisions is the bottom line of a truly patient-oriented framework. The respondents also added that the proposed supporting information system is a useful decision support tool that will not only empower the patients but will also strengthen their trust in the public healthcare system.

Currently most of them use other informational systems according to their positions, and thus they are computer literate. Most of them do not have any experience in using EDI systems. This leads to the conclusion that there are training programs in need for the healthcare staff, focusing on EDI systems that are necessary according to the respondents for this system information infrastructure. Most of the respondents are also not familiar with DSS. They are also familiar with ERP software, as there was an effort to implement a European funding program in order to provide ERP software to most of the public general hospitals in Greece.

Thus, a training program’s next step would have to focus on the value and usage of such patient quality systems and DSS.

The demographic data indicated that the larger the general hospital the more vague is the patient flow processes, schedules and treatment evaluations if any. The inefficiencies produced make the patients sceptical regarding their healthcare status. Such conclusions are important for the public sector, since the hospitals of the public sector are larger in size, and thus such systemic gaps and their measurements’ results negatively affect the national healthcare system’s profile.

5.4.2 Case Study: Private Sector

In the hospitals of the private sector, most of the doctors are familiar with DSS, and some of them already use them in other functional areas, such as insurance. On the other hand, they do not have any formal structural framework for patient flow in order to evaluate it accordingly. They were also relatively familiar with the ERP systems. They all admitted that this study's conceptual structure assists to effectively and efficiently operate this novel patient flow framework. They also underscored the importance of having data available that would prove a high quality service for the patient flow process and claimed that, according to their experience, patient satisfaction is primarily relevant to patient awareness and resources availability during the patient flow process.

Most structural inefficiencies were detected in the organisational structure, although they were monitoring patient services costs, to patient diagnosis and optimal treatment proposals. In this area, they had serious organisational gaps as most of their patients requested a second doctor's opinion for their diagnosis regardless of the problem's seriousness. They were all interested in a system that, based on process data, would automatically track the patient flow actions through the ontological model's structure. They were also interested in EDI procedures for the purpose of benchmarking other hospitals' structures. Currently, the patient flow process for both private and public healthcare is analysed in the next sections in an effort to analytically asses the system's needs for redesign.

5.4.3 Further Interview Discussions with the Doctors

Further discussion with the doctors revealed the effects that the lack of computerised dynamic formal structure in patient flow has for the patients. Both in the private and public sector, they all claimed that the patient currently picks their hospitals according to the doctors that they know. There are very few patients that trust the system without having what they called "their own doctor". Their condition treatment is not an informed process but rather an informal one taking place between them and their doctors whom they trust. Thus, even if they approach the system according to the 1535 appointment line in order to arrange a doctor's appointment, most patients especially if their condition is serious, are looking for a "second opinion". This second doctor's opinion is what counts for them. As they approach a doctor whom they trust, they will accept this doctor's opinion without any reservations. Most of them feel responsible for today's complex patient flow situation. So the proposed system will eventually restore the patient's trust in the healthcare system, as the overvalued relationship between patients and "their doctor" often has peculiar social interactions.

More than 10% (13%) of the population believed that the healthcare stakeholders currently contribute more than 100% of their professionalism in order to cover for the structural gaps of the healthcare system, which are substantial, according to them and the evidence provided in the study.

Finally, further discussion with the respondents for the structure of the Greek healthcare structure revealed that a different terminology for the healthcare flow level is used. In Greece, the primary patient flow and secondary patient flow structure is identical to the structure of the literature review, but the tertiary patient flow in Greece does not refer to rehabilitation treatment, which is in its infancy, but rather to medical research. For the purpose of this study, the international terminology presented in the literature review relevant to the healthcare environment will be adopted.

Relevant to the computing skills in Part B of the questionnaire, 35% of the respondents in question 1 replied that they were not computer literate including a majority of elderly doctors who claimed that they do not use the computer at all, although they understand its necessity. They did, however, have an assistant that supports them is such activities. Concerning the DSS question, the respondents who gave negative answers were completely ignorant of these tools. Even those that were aware of them were not able to define their usage. During discussion, most of them admitted that, due to ill-patient flow, patients pay sometimes more than once for specific examinations due to duplication of certain healthcare transactions especially those related to medical diagnosis and examinations. As far as quality measurements and their relevance to cost accounting were concerned, they were not aware of any specific program implementation that formally runs in any of their hospitals.

They were, however, all extremely interested in implementing one. They claimed, once again, that their patients should be satisfied with their efforts as the low level of patient satisfaction relating the Greek healthcare is not because of their services but rather due to the poor system's infrastructure and control. They also mentioned that any initiative in that direction, especially relating to the concept of this study, is welcome and useful.

5.5 Discussion on Findings

Based on the respondents' findings, the LAP communication framework included in DEMO methodology will assist in restoring the patient trust in the healthcare system. The problems identified in this survey are directly relevant and frequently analogous to the literature review of this study. This shows that hospitals in Greece share the same type of problems as other hospitals worldwide regarding patient satisfaction and treatment in healthcare flow.

Government directives and regional healthcare managerial units (PESY) are strongly enforcing the use of ERP systems in the general hospitals that have one. This ERP infrastructure will greatly improve the overall picture of these research findings relevant to the computing skills of the respondents. Together with the potential use of the EPR, it will also assist in the fine tuning of the supporting information system (POMR) proposed, making it a powerful decision tool for patients and healthcare stakeholders.

Intersubjective communication is imperative to be designed and encompassed through Habermas's communication principles in the ontological transactions analysed next, due to the nature of this study. Integration of all these measures and their value-added to the actor in each transaction should be electronically audited and stored through the ontological model's activities balanced scorecards. The CLIPS program will store the accumulated knowledge of the results. Therefore, following this discussion of the current limitations of the Greek healthcare environment relative to patient flow, the introduction of a patient-oriented supporting information system (POMR) in the Greek case is rather imperative and well-justified.

5.6 Systems Analysis

To proceed further with the analysis of the proposed patient flow, according to the DEMO methodology, the current situation's critical parameters should be considered as indicated by the questionnaire and interview of the respondents. Based on enterprise ontology, the next sections will map the primary medical processes and performance cells in order to form a novel healthcare orientation for Greek healthcare patient flow. Contemporary Greek patient flow transactions will be mapped in the subject world in an effort to design and measure transaction results and process steps for a patient-oriented flow as indicated by this study's research. The subject world's processes will measure trends in explicit contemporary knowledge and then will apply this knowledge to the object world. The tacit knowledge and practices of certain actors like the patients' "own doctors" of the subject world that is a part of the total knowledge that is applied in this healthcare flow goes beyond the scope of this methodology. This study's aim is patient-oriented treatment and satisfaction through the practice of explicit knowledge, which is expressed and measured according to the proposed ontological model. If an OS subject's (e.g., doctors') practices are based mostly on tacit knowledge the framework proposed will indicate through data analysis the degree to which such practices produce satisfactory performance results. For example, a doctor's medical operation methodology could be correct but outdated, and, thus, it might produce negative results for the patient flow. The supporting information system's performance ratio results will indicate such cases, and, thus, they could be used as a stepping stone for further examinations and solutions. Thus, with respect to the current Greek patient idiosyncrasies, a novel OS proposed will gradually restore patient trust. The framework of the ontological healthcare flow structure is simple and interactive in order to be easily communicated from the doctors to their patients at specific proposed steps of their flow. The enterprise ontology adopted assists in the three kinds of different systems implementation which functionally encompass the following: the social (the real essence of the enterprise), the conceptual (the knowledge systems) and the technical system (IT systems).

The US will be analysed in this chapter, according to the adopted methodology presented (Figure 4.6) with the assistance of this chapter's big picture and relationship diagrams. The aim of this US analysis is the systems division based on the above primary and secondary research findings. In this way, the US requirements will be set and the model construction of the US system will be designed according to enterprise ontology. Then based on the US model, an ontological construction of the US system redesign is in order to produce the OS. The OS produced is based on the redesign of the US. The redesign of the OS takes into consideration the requirements of the US according to Bunge's (1977) semiotic triangle (see Figure 4.2).

In line with what is referred to in the previous chapter as BB model, the OS of this study is a framework that is interactive in nature and that measures this study's concept per instance and then as a whole. Thus, the novel framework of the OS must be specified only in terms of the design of the US.

5.6.1 Requirements Analysis

To exemplify the systems analysis and requirements analysis, a general hospital is a part of the NHS. As a part of the NHS, a general hospital has specific needs for the doctors and other clinical staff, as they are components of its model and they need support. The general hospital as a BB model is a functional abstraction that may be useful for the big picture of the NHS (see figure 9.1), and at this level it is no longer about its implementation processes. On the other hand, the current implementation processes of the US are hierarchic in need, in order to deliver the novel OS function proposed through the concept of patient-oriented flow. Thus, first the big picture relationship diagram and second the structural decomposition in order to devise the systems specifications through ontological diagrams, based on WB model, are in order.

5.6.2 The Big Picture Relationship Diagram

Taking in to consideration the secondary research of Wolstenholme's patient flow process (Wolstenholme, 1999) and the Greek healthcare patient flow based on the primary research from the current processes from several healthcare institutions in northern Greece, the above figure exhibits the big picture of the current patient-oriented relationship flow diagram.

A patient with certain symptoms communicating with the 1535 appointment line enters the healthcare flow by receiving a doctor's appointment at primary level. This inflow transaction provides the patient with an indicated appointment. The parameters that relate to this appointment are the emergency nature of the condition and the geographical area of the patient as well as the doctor's availability for an appointment. Once the patient receives an appointment for the GP and visits the GP office, the patient receives a GP examination irrespective of the fact that often all medical exams are not in order for a diagnosis. Then, if diagnosis is possible, a referral from the GP for the general hospital's admission is in order. If the patient condition is serious, then usually the patient is referred for further examinations, then a new GP appointment is arranged. Usually the GP has no prior EPR or any other information that is relevant to the patient condition prior to the appointment. Thus, a GP's decision regarding the patient inclines to the understanding of the patient medical history prior to any examination. If there is no further evidence for examinations that are in order, the GP refers the patient to a nearby general hospital. The line of reasoning behind the GP's proposal is unclear. Then the general hospital's staff operates on the patient. The patient will be discharged from the hospital once the operation is over. This is the current patient flow process in Greece. Based on the description of the findings the following is the big picture relationship diagram of the current situation as opposed to the proposed one (see Figure 5.1):

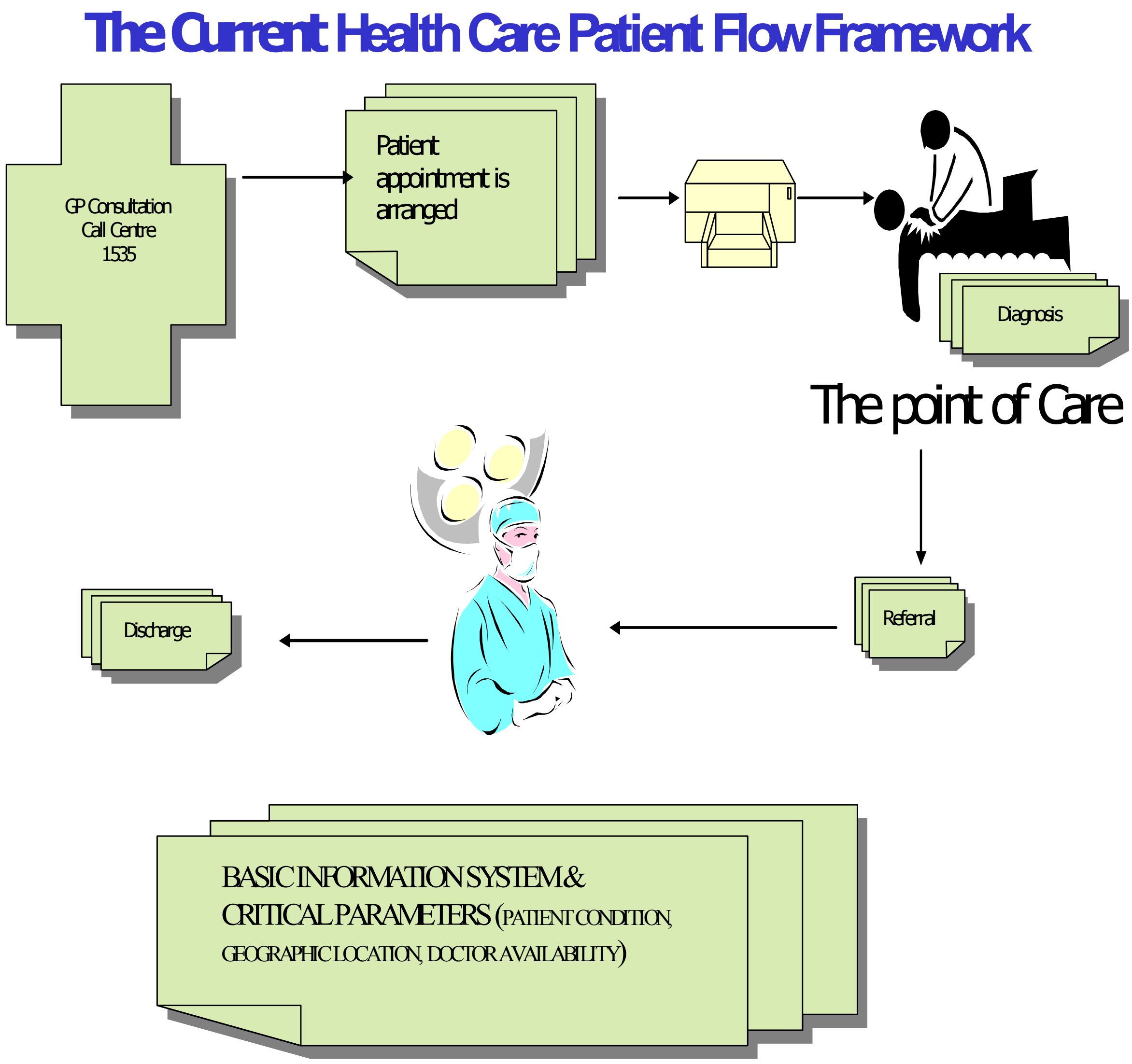


Figure 5.1: The Current Health Care Patient Flow Framework

This explicit picture analysis of the current situation which represents the US model and its design methodology through DEMO are exhibited next.

5.6.3 Requirements Analysis with Systems Devising Specifications

According to DEMO methodology and the last version of Xemod 2008, the current patient flow of Greek healthcare is structurally decomposed. The techniques necessary, based on the WB model of DEMO and the limitations currently in existence, are the Detailed Actor Transaction Diagram and the Process Structure Diagram. These enterprise ontology tools will assist in the findings of the current situation (US). The process of the patient flow based on the WB devising processes (see Figure 4.6: The Adopted Redesign Methodology) and the findings of this research have four primary US sub-processes which are exhibited in the following figure:

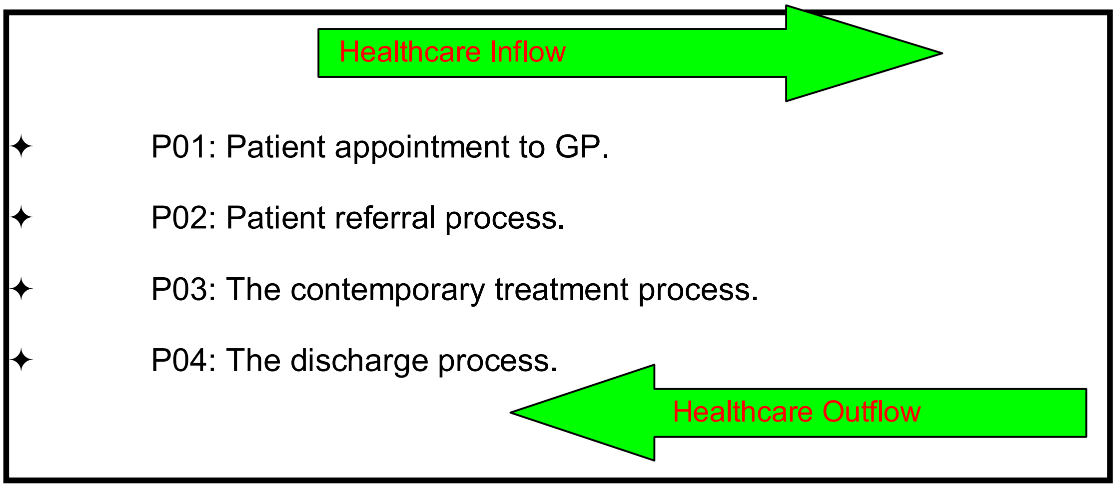


Figure 5.2: The WB Devising Processes

These current sub-processes need to be redesigned, based on ontological flow framework, with the support of the information system at info-logical and data-logical level (the figure's green arrows signify info-logical and red letters ontological level) and they are analysed to the following transactions:

- ✦ T1 Healthcare appointment request
- ✦ T3 Doctor's referral for further treatment
- ✦ T4 Hospital inflow
- ✦ T5 Hospital discharge and/or rehabilitation treatment initiation
- ✦ T9 Patient examination
- ✦ T11 Initiation of patient's treatment circle
- ✦ T13 Treatment
- ✦ T14 Doctor's expert opinion
- ✦ T15 Laboratory tests
- ✦ T16 Clinical tests

The above transaction pattern list is numbered according to the transactions that the patient has to currently follow from the time of entry the system until the time of leaving the system. The numbering of these transactions is cohesive with the proposed redesigned flow of the next chapter. The numbers that are missing are proposed transactions for the patient-oriented flow of the next chapter.

As enterprise ontologies are hardly applied in practice, the US structure usually lacks the step-by-step methodology that DEMO requires. At this step, alternatively a big relationship picture and a simple flow chart for mapping the following four sub-processes would have been enough. On the other hand, basic adoption of enterprise ontologies by the US is also possible and actually makes it easier for the reader to comprehend the concept of this study. The reason is that both US and OS are redesigned based on enterprise ontology, and, thus, the value-added of the redesigned flow is easier to see. The results of each transaction are very important, and, ideally, they have to be defined briefly and exactly for each transaction, so they can be measured. The result structure and hierarchy of the current flow should also be exact.

Based on this study's primary research, these result values are hard to define briefly and even more so to be assigned hierarchically to specific transactions. They are, however, included in the relationships diagrams analysed in this section. In these diagrams, the transactions are presented as diamonds inside the circles.

As explained in the previous chapter, the circle signifies the "c world", which means that the system's actors are coordinating in order to produce results that are signified with the "p world's" diamond that is inside the circle. Actors are noted inside a square box that signifies that they have the authority according to this model to act according to their roles. The actors have two types of roles, elementary and composite. The elementary roles contain no specific interaction with other actors relevant to the result produced, and they are signified by a blank square. The composite role actors are signified by a grey square, and they are actively interacting though intersubjective, Habermas communication code, as explained in chapter eight, with other system's actors. The actors' coding is:

1. Composite Actor 1(CA1) for Patient actor
2. Elementary Actor 2 (A01) for call centre personnel
3. Composite Actor 3 (CA03) for GPs
4. Composite Actor 4 (CA04) for clinical personnel

5. Composite Actor 5 (CA05) for medical experts
6. Composite Actor 6 (CA06) for rehabilitation personnel

According to the doctors' interview, all these actors are composite actors and not elementary, as they do carry the full responsibility of their transactions for the patient's condition result. Their individual responsibility as well as their authority according to the findings of this research is a part of a larger internal environment with specific processes and policies (e.g., hospital) as well as a part of another external environment (the NHS).

Concluding, these acts, which will be analysed next could be based on specific measurable conditions, which, once they are satisfied, could express the proposed patient service type level and design of the patient-oriented concept. These conditional qualitative acts could become facts with specified results, once the diamond scheme of execution act can produce a satisfactory measurable performance result. The exact ontological diagrams that are representing the following prototype are included in Xemod 2008 software package. These original Xemod structural diagrams and reports are included in the appendix section and software attached (Dietz, 2006). Encountered lack of processes and transactions, which vary among general hospitals in northern Greece, obliged the researcher to undertake the initiative of describing the best case application scenario. Due to the interview respondents, the Papanikolaou general hospital as well as AHEPA general hospital applications of contemporary patient flow were selected as hospitals that represent a complete healthcare service pattern of the following contemporary processes. The large solid frames denote the healthcare institutions where the actors are performing their acts. Once again, these boundaries are rather symbolic for the public sector, as primary and secondary level transactions take place within the secondary healthcare institutions. In an effort to build a model in a compatible and comprehensible way for the reader, the contemporary situation has also been identified and produced as accurately as possible with the same enterprise ontology software package Xemod 2008 as it is the novel proposed model.

5.6.3.1 US Process 01: Patient Appointment to GP

The DEMO process structure diagram shows the coordination acts and the production act of each transaction. Each transaction follows a predefined order of coordination acts, broken by a single production act. The success path of a transaction is a sequence that consists of two coordination acts, request and promise, followed by a production act, which is followed again by two coordination acts, state and accept. This US process structure follows the WB model, functional decomposition, which is explained in the previous chapter.

At the operational level, in order to go through the GP appointment process, a patient today makes a call at patient's charge to a call centre line 1535. According to the recorded message of this line, this call is charged to the caller, of this line, at the average price of a local phone call in Greece. So the patient initiates the first action of the flow process. This call centre is not directly responsible for the arrangement of any other healthcare transactions. Other transactions, like appointments for examination referrals, are arranged either after communication with the relevant healthcare provider or directly from the patient with the relevant referral from the healthcare provider. The transactions included in this process are the following:

<u>T01RQ/PM/Execution/ST/ACC: Doctor's Appointment.</u>

The patient has to declare the name, public insurance data and a request for an appointment. This information is necessary for both private and public healthcare. The main reason is that all public insurance programs compensate the full amount of the appointment for public doctor's fees and also up to a certain percentage a private doctor's fees. For a public doctor's appointment, further information is requested. Such information includes the patient's geographical location and doctor's requested expertise. Public healthcare doctors are not currently involved at any point in this process, which is solely managed by the secretarial staff. In private healthcare on the other hand, this process varies among offices. The appointment arrangement in public healthcare is set when there is available time based on the doctor's expertise and the geographical limitations requested, regardless of the patient's needs. That means that the patient states the need for a

GP or an expert doctor depending on the medical condition that he/she is experiencing. The appointment parameters taken into consideration are the available requested doctor's dates for the appointment as well as the healthcare organisation in proximity to the patient's location. For public healthcare, evening hours are available for free patient's visits. Each patient visit to a public doctor currently is fully subsidised by the public insurance funds. It is a ten minute appointment, where the doctor has to perform the diagnosis and then to follow processes similar to this study's, often without the specific hierarchical order concerning the existent flow transactions. In the case that the patient condition demands further examinations, the patient receives an examination referral from the doctor and rearranges an appointment for examination analysis with the hospital's assistance in order to obtain the necessary diagnosis.

In private healthcare, patients usually also have to make an appointment with a public GP's office. The reason is that when they visit a private doctor, their "own doctor", they received further examination referral. If they wish to receive public subsidy they have to visit a public doctor again to obtain a relevant referral, if possible. Otherwise the examinations performed are not publicly reimbursed.

Both public and private doctor's costs per visit are approximately the same. Public healthcare subsidises 100% of the public doctor's visit cost. The doctor receives 50% of this visit compensation and the public healthcare organisation the other 50%. Without the direct assistance of the call centre, once the patients receive the examination results, they have to wait once again for another doctor's appointment without any priority, regardless of the situation's seriousness. The request for a new appointment is again feasible through the national call centre line. It is also possible for the patient to receive an appointment with another doctor this second time, as the doctor that this patient visited the first time could be scheduled in the system for a long time. If the situation is urgent and the patient does not wish to go through the same process again, then the patient visits a private doctor. These are the current transactions of the process 01 which are being handled by two actors (composite actor patient CA01, and elementary actor secretary, call centre A01).

Based on these current transactions regarding the process of requesting doctor's appointment, the following problems occur:

1. As there is no EPR spine the patient's name could be misspelled or two patients with the same name may appear for appointment.
2. The patient may never go to the appointment.
3. There is no tracking for appointment cancellation.
4. Many brief appointments are missed.
5. A brief appointment lacks patient respect.
6. Lack of EHCR and EPR information result in lack of evidence required for examination.
7. Older patients especially often have to repeatedly rearrange appointments due to lack of examinations requested for a doctor's diagnosis.
8. Bureaucratic procedures are in effect due to lack of efficient transactions linked to specified results and technological processes.
9. There is not a performance appraisal framework in effect.

Based on the current situation, the following figure demonstrates the actor's transactions in the process model of the current appointment process:

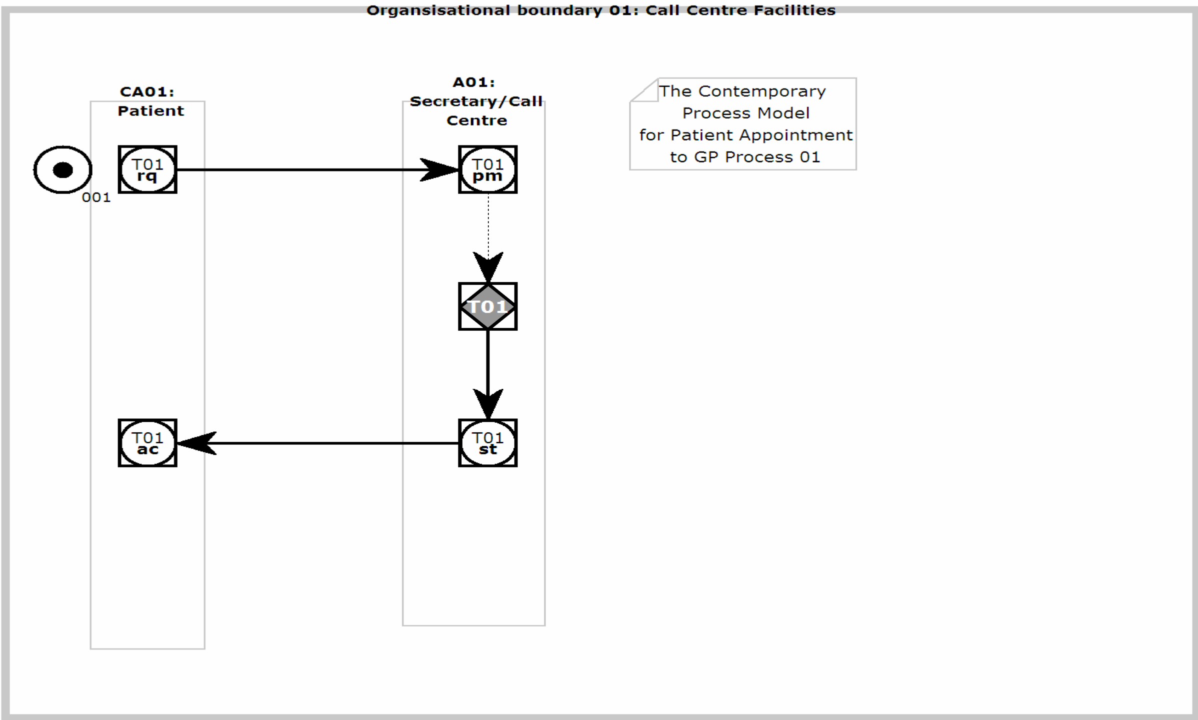


Figure 5.3: The US Process 01 Model of the Contemporary Situation

According to the adopted methodology (see Figure 2.20) the next step is the proposed novel process which will be represented in the next chapter.

5.6.3.2 US Process 02: Patient Referral

<u>T09: Patient Examination.</u>

The patient arrives at the doctor's appointment and the doctor promises to see the patient. The doctor checks for electronic patient data if available. It could be available, if the patient entered the same general hospital previously.

Then the doctor performs the examination but due to the patient's condition may need additional medical examination in order to make a diagnosis. The patient has to enter the hospital loop again, most probably outside the call centre's appointment line, as this service is only available for doctor's appointments, and further examinations requested from the doctor's referral are handled at hospital level.

T15: Laboratory Tests, T16: Clinical Tests.

Hospital facilities frequently do not have the necessary infrastructure to perform the laboratory tests required from the referrals, and the patients have to go to another location to have them. In any case, rather than proceeding to the next healthcare level with the proper diagnosis and referral the patients are sent back for further examinations and appointment arrangements, which were not set ahead of time although they were most probably necessary. So, once again the referral for further examinations is set with an appointment arrangement within the general hospital facilities. If the hospital lacks the requested technology or the equipment based on the referral, then the hospital is responsible to arrange an appointment at another nearby hospital. The patient has to wait for an available appointment. The same case occurs concerning referral for an appointment with a specialist. The appointment set this time depends on the patient's medical emergency.

T01RQ: Request for a Doctor's Appointment.

When the examinations are carried out, then the system requires a rescheduling for another available doctor's appointment. The system proposes a date when there is an opening for such a doctor's visit. It is possible that at this second appointment the patient will not see the same doctor. As a result, the exams performed could be considered either incomplete or even unnecessary, according to this second doctor's opinion. It is obvious that the patient fate is completely dependent on the doctor's tacit knowledge.

T03ST: Doctor's Referral for Secondary Level Treatment.

On the other hand, the patient may be lucky and receive a doctor's referral for secondary level treatment. Such an ad hoc decision depends on the complexity and seriousness of the patient's condition as well as the doctor's expertise relevant to the patient's condition. In any case, the patient enters a healthcare flow labyrinth, where the process paths are definitely haphazard and often redundant in their nature. The result of this situation is not only that the patients may have to enter a series of multiple and unnecessary appointments but which the appointment call centre line 1535 could block due to this overload of repetitive doctor's appointments. This is primarily the reason that, in Thessaloniki, the average appointment lead time for public doctors currently varies from 30 days for a GP (pathologist) appointment to 6 months for an appointment with a cardiologist.

Based on the current situation, the following figure demonstrates the process model of the patient treatment referral process. The actor call/centre, secretary is an elementary role as it does not assist in any actions relative to patient relationship management.

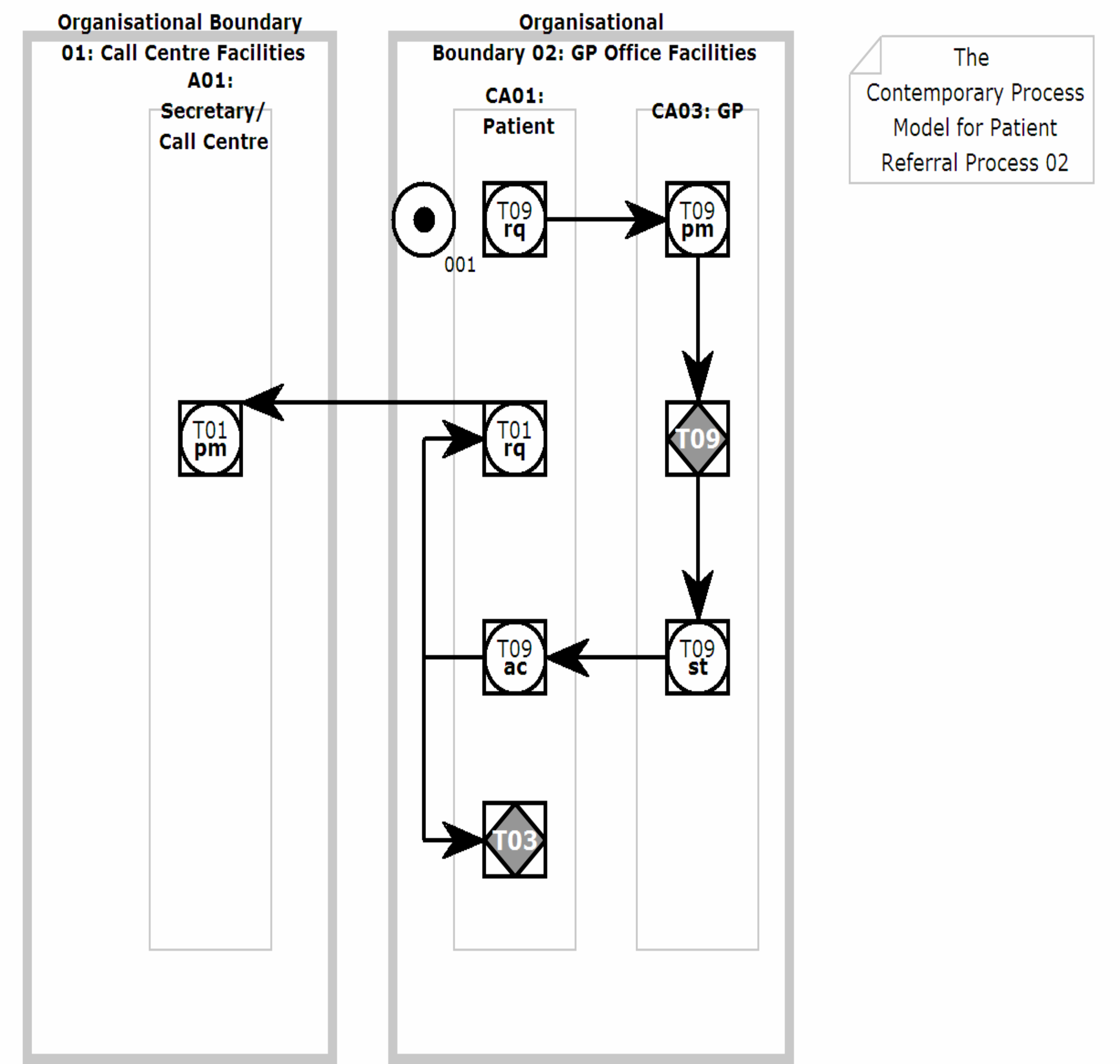


Figure 5.4: The US Process 02 Model of the Contemporary Situation

The above figure exhibits the transactions that take place for every appointment between patient and doctor. The process from the examination results acceptance of the patient (T10 acceptance) is haphazard, as there are multiple choices due to lack of policies and procedures from all the previous system's gaps presented in this section. Thus, this figure ends at the point where the systemic transactions end. All other transactions to be followed in the patient's flow, at primary level, are based on the doctor's decision-making process. Such a process is beyond the scope of this study, as it is relevant to tacit rather than explicit knowledge, which is the focus of this study. Thus, the referral transaction could be completed after a series of multiple appointments and time spent by the patient, call centre, clinical labs and GP actors. That is why the figure 5.4 ends with the initiation of a loop for the first contemporary process again (P01).

5.6.3.3 US Process 03: The Treatment Process

This process initiates with the GP's referral which is valid for a certain period of time, usually a month. It ends with the patient accepting the result of this process that must be optimal patient treatment, based on the level of efficiency and effectiveness that each transaction act delivers. Once the reconstructed process is delivered, then these levels will be measured next to ensure that the acts of each transaction are implemented and thus turn into facts.

<u>T03RQ: Doctor's Referral</u>

Once the patient accepts the doctor's referral, the next step is the hospital inflow. The patient leaves the doctor's public office, which is often inside the general hospital where the patient will be admitted, and communicates with the clinical personnel.

<u>T04RQ: Hospital inflow.</u>

Upon patient request, based on the doctor's referral, the clinical personnel inform the patient when the hospital inflow process will occur.

T04PM: Hospital inflow.

Frequently, this promise for hospital admittance is not immediate due to common patient overload of the general hospitals. There is currently a lack of any formal process, aside from the formal patient registration at the hospital's record, for priority or hierarchical arrangement for the general hospital's admittance. This means that this promise for patient inflow is haphazard, oral, and, although the patient case is registered accordingly in the hospital's records, the patient has no formal form or any other type of document that informs him/her of the admittance date.

If there is a need for immediate hospitalisation, then there is a good chance that the patient will be accepted "conditionally" in a bed frequently located in the hospital's corridors. Although not the optimal option, the patient receives immediate hospitalisation until a proper bed is in available. It is still, however, at transaction T04 promise status until further notice. Thus, it is also not unusual that, if this period is prolonged, the patient to leaves public healthcare and enters the private sector.

T04Execution: Hospital inflow.

Eventually, besides the above "conditional" admittance, when the patient is admitted and transaction T04 is executed, the patient receives a room, doctor and other hospital tangible and intangible resources according to the availability at that time. All expenses for the resources provided are 100% paid by the patient's public insurance.

T04ST: Hospital inflow.

Once the patient is admitted, an announcement of the potential treatment is communicated orally by the clinical staff. The doctor that is assigned to the specific patient's condition, in the best case scenario, meets the patient in person minutes before operation time. Generally the patient is vaguely aware of the hospital flow and treatment horizon. Any requests for specific hospital resources are simply not possible or operate on a haphazard status. So, this act is a public healthcare statement that is considered as a given of the system's fact without any regarding measurements.

T04ACC: Hospital inflow.

The patient accepts the statement and naturally requires performance treatment as soon as possible.

T17RQ: Performance Treatment

The patient orally requests performance treatment as mentioned above. The situation is that as the T04ST is considered a fact, an informal and most usually unnecessary negotiation for priority arrangements for performance treatment occurs. Sometimes, however, it is possible, for socially related reasons outside this study's domain, through this informal act (T18 RQ) that the patient manages to receive treatment in a short performance horizon or even with the doctor requested. The T17 transaction is not electronically recorded like the novel T17 transaction in the next chapter.

T17PM: Performance Treatment (not electronically recorded).

The clinical staff promises that the hospital's oral treatment plan, or rather promise, will be followed. Alternately, due to the previous act, the patient request is also an option.

T17: Performance Treatment Execution (not electronically recorded).

Upon treatment, execution the actor "doctor", who is the initiator of this act, orally informs the patient relative to operation procedures. This communication is always informal and is of a psychological nature rather than of a medical one. Then the operation takes place without any specific medical methodology disclosed to the patient.

T17ST: Performance Treatment (not electronically recorded)

Once the previous execution step is finished, then the initiator of this act who again is the doctor, states the result. This means that if the treatment execution result is positive, everything is well done. On the contrary, if the treatment execution fails, then the patient has no formal data as evidence for potential malpractice, and this act ends at this point.

T17ACC: Performance Treatment (not electronically recorded)

The patient that initiates this act accepts the result of the operation. If the result is positive, then the patient receives handwritten treatment of guidelines, less than a page usually, and the dismissal transaction is in order. If the treatment performance is unsatisfactory, a variety of situations, not directly relevant to the scope of this study, may occur. Due to lack of transactions relating to results based on medical evidence, the performance treatments from general hospitals could easily be biased or even manipulated, and the patient has to accept them. This is the situation currently for the treatment process in Greece. For the record, many outstanding court cases for malpractice in public general hospitals are pending due to this contemporary situation.

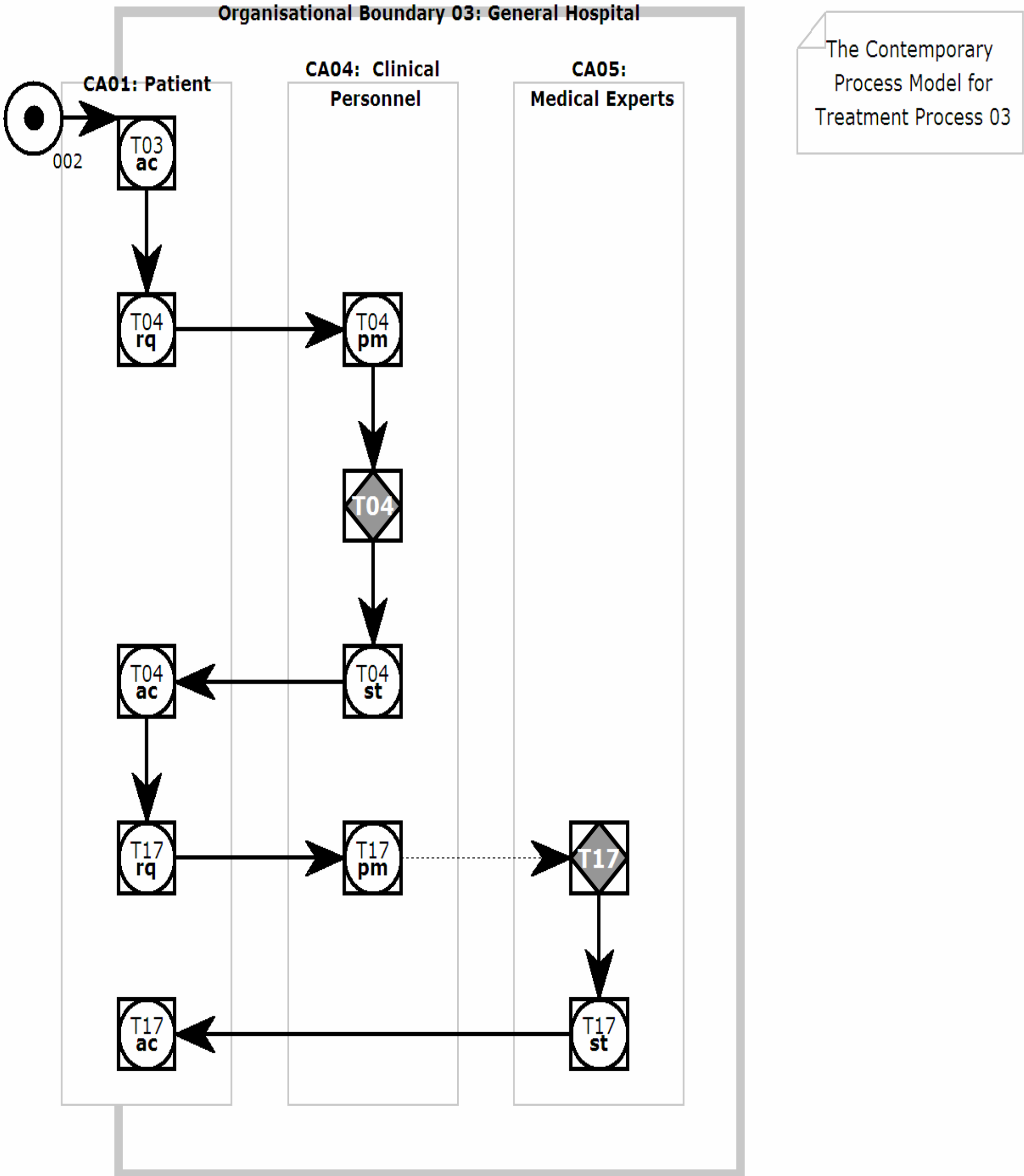


Figure 5.5: The US Process 03 Model of the Contemporary Situation

5.6.3.4 US Hospital Discharge and the Rehabilitation Process

The contemporary process of patient discharge from a general hospital as well as the potential further treatment in to a rehabilitation facility has three basic actors:

1. The patient
2. The clinical personnel of the hospital
3. The medical experts

This process follows the treatment process and focuses on the series of acts that are in order today for a patient to be discharged from a general hospital. It starts from the last patient action of the previous, current third process, which is the acceptance of the treatment performance.

T05RQ: Hospital discharge and/or rehabilitation treatment initiation

The patient usually is seeking information regarding the discharge process. Specifically the patient is seeking the proper documents both administrative, for a full public compensation depending from the insurance status, and medical, for exiting or further continuing the treatment rehabilitation. The actual initiator of this discharge, however, is the doctor who requests the transaction initiation once the patient condition needs no further hospitalisation.

T05PM: Hospital discharge and/or rehabilitation treatment initiation

Usually the clinical personnel follow the initiation of the act of hospital discharge by delivering an oral promise of the discharge process that is specifically relevant to the administrative staff of the hospital. The patient expects the discharge document that usually is enough for full coverage insurance status. Sometimes, however, since public insurance does not fully cover certain procedures, the patient might have to visit the hospital again to receive extra discharge documentation requested. At this point, no information is available regarding the patient's rehabilitation program.

T05: Execution of hospital discharge and/or rehabilitation treatment initiation

The clinicians usually execute their promise as soon as possible, due to hospitals' admittance waiting lists and prepare for the discharge document and a hand-written brief rehabilitation report document that specifies further treatment proposed by the medical personnel for the patient.

T05ST: Hospital discharge and/or rehabilitation treatment initiation

The clinical personnel initiate this action as they inform the patient of the discharge status and orally explain the rehabilitation report, according to their good will. This act is necessary, as the patient is not in a position to fully understand what has to be done for future treatment, since it is usually impossible not only to read but also understand this hand-written report.

T05ACC: Hospital discharge and/or rehabilitation treatment initiation

The patient initiates this act by accepting the discharge documentation, which is necessary for the insurance coverage. At this point, if the patient is fully treated and the discharge documents are in order, then he/she exits the patient flow without following any further transactions relative to this process. On the other hand, if the patient needs further treatment he/she engages in an extensive conversation in order to understand the proper rehabilitation route based on the rehabilitation procedures report that is the result of this process.

T06RQ and Execution of patient monitoring

The clinical personnel initiate this act by agreeing with their senior medical doctor who is the head of their team to provide oral information regarding the patient's schedule of periodic rehabilitation visits. According to the patient record, this act of a proper treatment evaluation is charged to the operating medical expert. Such an act usually results in a future proposed appointment always in relation to the rehabilitation methodology delivered in the previous transaction.

T06ST: Patient monitoring.

The statement of the rehabilitation treatment based on hospital discharge is usually given immediately and directly by the medical experts' assistants whose doctor team leader is responsible for the rehabilitation process. Such an act is oral and informal, as the medical doctor is usually engaged in other activities relevant to the heavy hospital patient inflow. On the other hand, as appointment policies vary according to the hospital's patient flow, this statement is an important piece of information critical for the patient's awareness regarding the monitoring of rehabilitation. This statement does not contain any information relevant to the administrative process for making these hospital appointments which varies greatly among public hospitals.

<u>T06ACC: Patient monitoring.</u>

The patient initiates this act by accepting all the relevant information that is provided by the specialised medical personnel based on the rehabilitation report. Once the patient understands this transaction step, then together with the discharge document he/she leaves the hospital.

The above transactions' analysis is exhibited in the following figure:

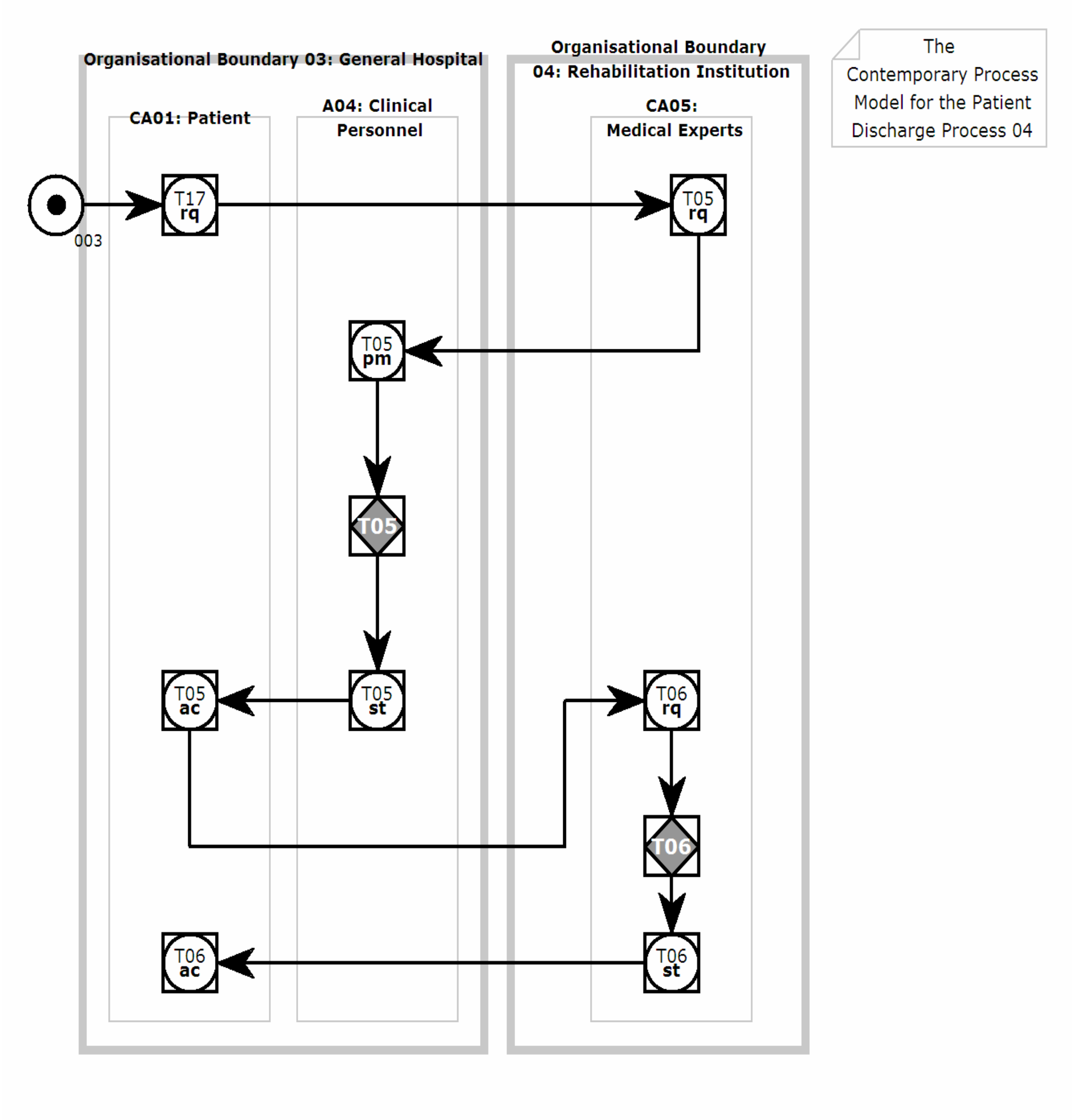


Figure 5.6: The US Process 04 Model of the Contemporary Situation

Based on the above structural decomposition for the OS analysis requirements their identification step according to the adopted methodology (see Table 4.1) is next.

5.7 Identification of Redesign Requirements

In this section, based on the adopted WB modelling of the DEMO methodology, the necessary system requirements are presented, analysed and finally defined. According to DEMO, however, the ontological model of a system is completely independent of the way in which it is realised. The following requirements should be considered for the core implementation of the proposed patient-oriented flow framework. According to the adopted methodology step 3 (see Table 4.1), the current situation decomposition resulted in the following redesigning requirements Table 5.1:

1.	A transaction structure that focuses on the patient relation.
2.	A framework designed to measure the patient satisfaction and treatment level.
3.	A framework able to serve as a campus for NHF.
4.	Design of a model that will assist in estimates for costing per patient condition
5.	Model transaction results and transaction hierarchy that will aim towards regaining the patient trust in the healthcare system.
6.	Patient flow transactions focused on patient ad hoc service with long term value-added.
7.	Patient ability to pay for results and not for procedures.
8.	Patient choice to be supported by value-added information.
9.	Empowering patient decision-making towards value-added results
10.	Treatment of the patient not to be primarily subject to healthcare assets limitations.
11.	Systems interoperability focus and specifically EDI leading to EPR
12.	Ability to design CPGs which will require formal patient-oriented flow procedural structure.
13.	Potential for patient condition service evaluation level.
14.	Information disclosure to be linked to specific structural transactions with simple and measurable information.

Table 5.1: Identification of the Redesigning Requirements

Finally, the OS has to be developed and analysed based on the above US analysis specifications of the four WB model sub-processes. The construction of this necessary model and OS will satisfy the aim of this study encompassing respondents' surveys and secondary research design requirements.

5.8 Summary

This chapter devised, analysed and proposed core design specifications according to the healthcare flow structure of the contemporary situation in Greece based on the ontological redesigning methodology adopted in this study. This designing system process produced a decomposition of the US patient flow model to four WB model sub-processes as exhibited in the above four Figures 5.3, 5.4, 5.5 and 5.6. Each sub-process is deliverable from the previous one according to the specifications set out in the system's transactions steps. Thus, the redesign of the patient flow starts from the re-conceptualisation of the US ontological model as delivered in this chapter. The redesign of the US to and OS is necessary in order to capture the fundamental conceptual difference between patient-oriented flow and non patient-oriented flow service.

According to this chapter's primary research, it is obvious that the Greek healthcare environment lacks the necessary organisational cohesiveness regarding issues relevant to the patient flow. The questionnaire respondents' interviews were essential in order to devise the contemporary processes of the patient flow to sub-processes and transactions. The main reason was that enterprise ontology is hard to capture in practice due to the US's lack of the necessary info-logical, data-logical, and ontological infrastructure necessary to support the concept of this study.

Finally, the respondents showed great interest in this study's conception. This patient empowerment through a model and its supporting information system could provide informed decision-making for the aim of this study. This framework will provide the necessary evidence and information for the proposed patient-oriented flow presented in the next chapter.

Chapter 6 OS Redesign: DEMO

6.1 Introduction

The aim of this chapter is to proceed to step 4 of the adopted DEMO methodology (see Figure 4.6) and redesign and develop the OS that will be used for the transformation of a healthcare-oriented patient flow to a patient-oriented performance flow. These sets of rules and procedures have their basis in accredited techniques and tools consisting of a series of activities that allow the accomplishment of specific well defined results. Basic key concepts of DEMO methodology at this step 4 will also be presented in order to further analyse the roots of this redesigning methodology.

6.2 The Redesigned Ontological Conceptualisation of the OS Function

Four the DEMO methodology is based on Bunge's ontology (Bunge, 1979). An ontological model links the definitions of sign, object and concept through the semiotic triangle. A sign is used as a conceptual representation of something else in the semiotic triangle (Figure 6.1). For example, the "Patient-oriented healthcare" etiquette that is used in this study represents the type of healthcare that the object "patient condition" receives in a healthcare system. The subject "patient" could communicate with the other subjects for its "patient condition" (object) and these communication process steps as well as other healthcare transactions represented next will be measured based on the performance measurement's collection included in the model's supporting information system. The subject "patient" has every democratic right to act based on his/her factual, tacit knowledge and exit or choose alternative flow paths of the healthcare system following the rules of the intersubjective world. This methodological step will re-evaluate the services of the object relevant to this flow concept that bears the sign patient-oriented based on the novel collection of measures analysed next.

Thus, ultimately, the concept of a patient-oriented flow is a subjective individual parameter, unless it possesses properties of classification based on objective measures that symbolize a patient-oriented healthcare according to the national healthcare strategic framework of each country. The subject of patient-oriented flow still is, however, by definition an abstract subject that is directly relevant to the concept of this study.

Thus the patient-oriented healthcare ***sign relates*** *to a patient-oriented flow* ***concept*** *and should* ***denote****, through ontological acts and objective measurements, the* ***object*** *of a patient condition service type in order for this concept to be* ***referred*** to *as a patient-oriented patient flow*.

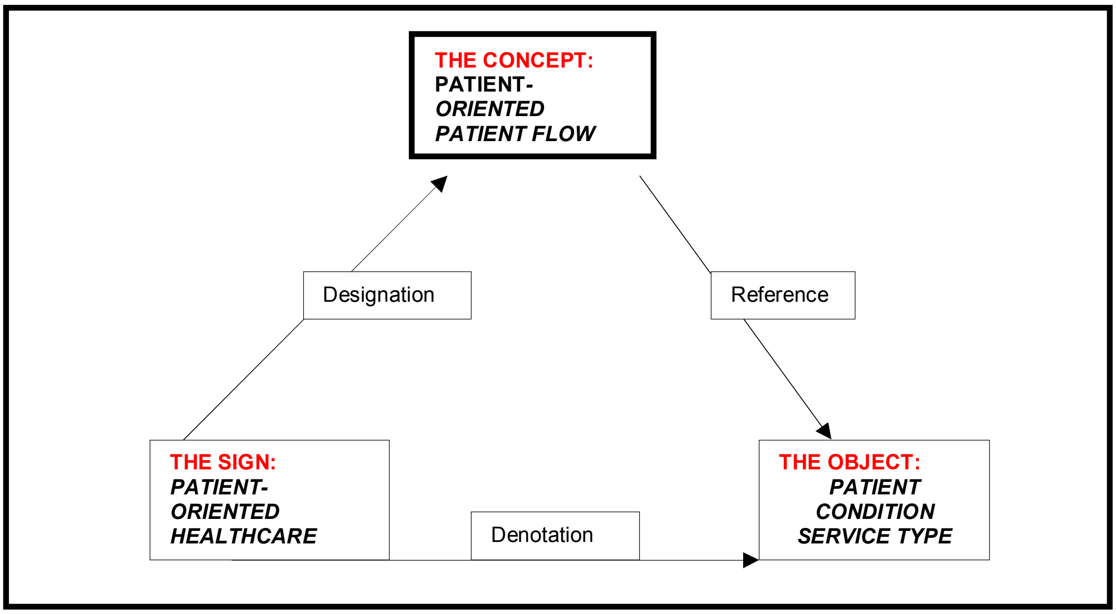


Figure 6.1: The Patient-oriented Semiotic Triangle

Hence, the sign or symbol or mark of patient-oriented healthcare is a symbolic sign that designates the OS structure of the patient-oriented patient flow. The patient-oriented patient flow concept is a subjective individual thing. It is a mental picture of the subject's head (e.g., doctors) and refers to inclusive measurable ontological parameters of the patient's health condition. In the OS, the patient health condition is relative to treatment for all medical types of patients' conditions depicted in the ontology parallelogram (cardiac patients, orthopaedic patients, etc…). It also refers to the satisfaction results levels, as they collectively constitute the "form" of the object. Although there are a potentially unlimited number of service types for the OS, two result or "form" types are proposed based on a potential national condition threshold measured through patient value-added service. These results, based on the patient value-added formula (see Table 6.4), are type A: patient satisfaction presence or type

B: patient satisfaction absence. The exact values of this service type are directly relevant to any NHF, as the concept of a type is a subjective thing. The object “patient condition service type” is also abbreviated and referenced in this study as “patient condition,” since according to the ontological parallelogram the “patient condition service type” conforms to the “patient condition”. Thus, the designation and the reference denote the object “patient condition” that actually is directly related to parameterised, measurable ontological transactions initiated by the subject world, and they are necessary in order to “form” a specific type of service based on their performance. For example, doctors as actors of the subject world could take certain actions relative to the “patient condition” based on this chapter’s ontological business rules and their results. Each instance’s data accumulated is stored in the intelligence supporting information system proposed, tagged as POMR operating with CLIPS technology. Finally, without the denotation of the “patient condition,” the idea of “patient-oriented healthcare” is meaningless. Now, all service types of patient conditions are extended to the class of elective patients’ medical conditions that includes both privately or publicly treated conditions through a healthcare system. These conditions have a specific population that the patient-oriented patient flow could manage in a patient-oriented way at any given time. Thus, the following ontological parallelogram is formed:

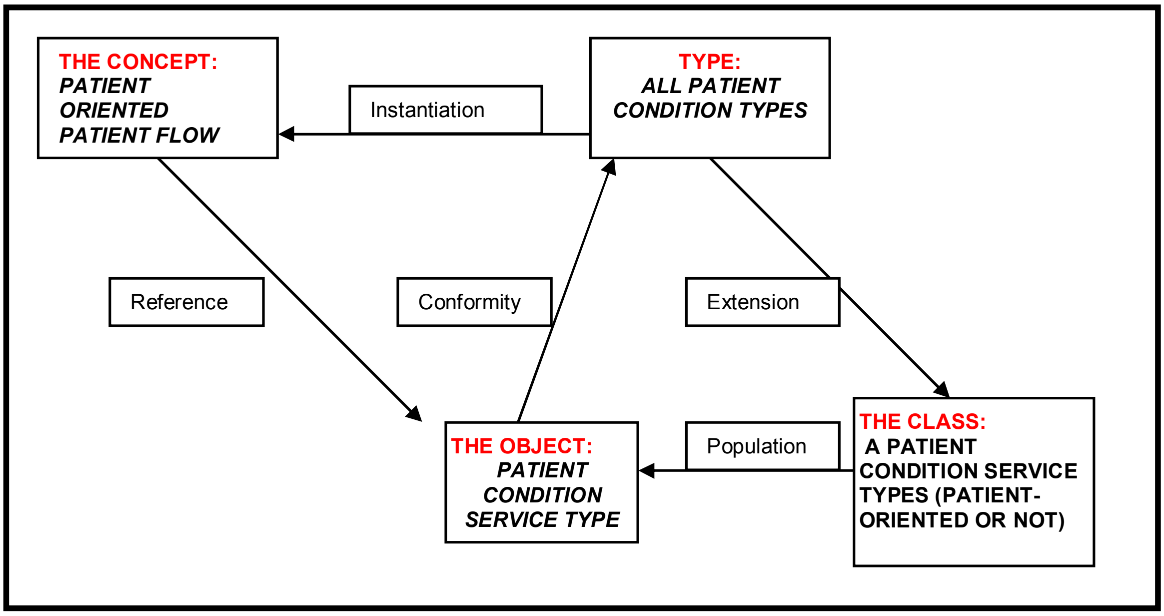


Figure 6.2: The OS Ontology Parallelogram

The above parallelogram completes the factual knowledge of the ontology and together with Bunge's semiotic initiates the step 4 of the adopted methodology (see Figure 4.6) necessary for the redesigning of the OS triangle within the conception of this theory. Thus, the ontological foundations, both conceptual and factual, exhibited respectively in these figures (Figure 6.1 and Figure 6.2) stipulate that the patient-oriented flow is subject to certain parameterised ontological measurements based on structural ontological rules that represent a specific "state" or "form" (patient-oriented or not) of the patient medical condition of the objective world. Thus, the measurements functionally "form" the concept's "state", which could be patient-oriented or not. The performance measurement supporting information system (POMRS), based on the redesigned ontological structure proposed next, will measure the "state" of the objective world and clearly define the patient value-added service type of the mental picture of this study. The information system's measures analysed at info-logical and data-logical level that resulted from the primary and secondary research of this study will be directly linked to the ontological model's acts and transactions. The following organisational theorem exhibits the supporting levels of the novel ontological framework (Dietz, 2006):

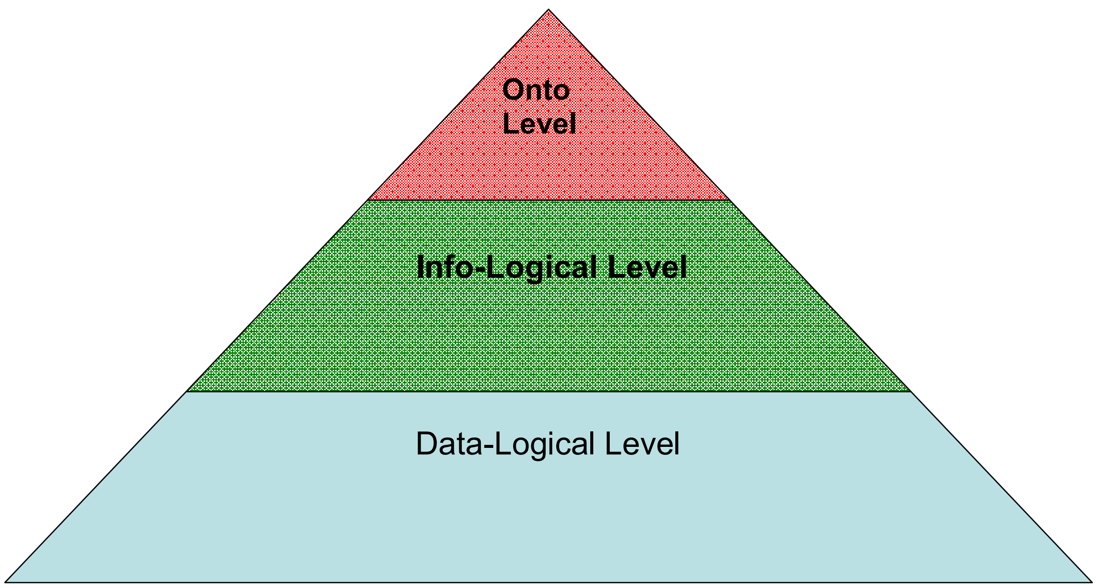


Figure 6.3: Organisational Theorem

Based on this ontological framework, evaluation of the patient orientation concept of the flow could be produced as all the systems' data instances will be stored in the supporting information system produced in CLIPS language. Any other type or structure of flow is outside the patient-oriented concept presented in this study. Thus, all patients' condition types are included in the ontological parallelogram, once they are an instance of the patient-oriented flow, which means they are all treated based on the minimum thresholds and standards that the performance measures framework will provide and store for evaluation.

The concept of the patient-oriented patient flow will thus refer to a minimum standard of acceptable patient condition service based on national healthcare strategy. This patient condition will conform to all patient condition types that will enter the model as instances. This means that the patient entity of either type (A or B service level type) received an objective minimum for national patient-oriented treatment. This objective minimum threshold set for type A or B services will be indicated by the country's national healthcare strategic network. According to the literature review of this study, each patient instance of this flow may request additional subjective standards based on the patient's profile that might be satisfied or not. In any case, this ontological structure could be parameterised ultimately in order to satisfy future subjective patient standards. Nevertheless, a life-long relationship could be obtained through this ontological model structure. Lack of this model's actions on the one hand may conform to the NHF economic break-even point but not to the OS (Lepouras et. al., 2005). Thus, any additional services required on this ontological model structure are possible due to the dynamic nature of the model and tools that are used which could satisfy any institutional strategy.

6.2.1 Devising Ontological Specifications: DEMO Techniques

Initially DEMO was introduced in 1992, at Delft University of Technology, by Dietz (Dietz, 1992). DEMO – Design & Engineering Methodology for Organisations is a methodology for organisation engineering and reengineering. As of 2008, the last version of the Xemod software tool is used for the development of specific models, which, based on the DEMO techniques, are necessary for developing an ontological model. The models analysed are based on the dichotomy of the subject world and the object world that separates their actions. The intersubjective world through enterprise ontology forms a communication model where the subjects' actions have direct impact on the status of the object. Subject entities include healthcare stakeholder entities responsible for the object that is the "patient condition type".

As mentioned earlier, before the communicative theory of John Searle and Jurgen Habermas (Dietz, 2006) is a DEMO concept that is based on LAP theories, and specifically to Stamper's ladder (Dietz, 1991) specifically provides an elementary communication framework for mutual understanding in the intersubject world and potentially for the object's world. This DEMO's framework of essential, informational and documental parameters is the development of the physical, syntactic, semantic and pragmatic parameters framework. This study's ontological performance measures, provided by the supporting information system, will assist in these subject's dialogues as it measures with objective standards their results with respect to the OS concept. The DEMO transactions are compatible with performance measurements which are considered necessary for a scientific approach to business process redesigning. As the communication occurs, the basic elements of this communication are defined, based on the organisational theorem of the enterprise ontology to documental (data-logical), informational (info-logical) and essential (ontological) playing a role in the operation of actors defined as performa, informa, forma. An actor, in order to perform these distinct human abilities, needs a certain level of support from a specific organisational level where these actions belong. (see relevant Figure 6.3).The organisation is a heterogeneous system that involves different organisational levels, one in support of the other. Each layer supports the one above with the ontological level on the top. The first level, which is the organisational base, is the data-logical level or the D-organisation. It focuses primarily on the organisation's infrastructure, so it is mostly IT with a documental oriented philosophy assisting the analogous actor's forma performance. Thus, at this level the organisation ensures the necessary tangible assets, like the CLIPS software technology, for the operation of the next organisational level according to this organizational theorem (Wand and Weber, 1995).

The next organisational level is the info-logical level or the L-organisation. The info-logical level is the level where the support of the first level is in order. The necessary supporting information system (POMR) and CLIPS software technology at data-logical level assists the relevant actor's informa performance. Finally, the top organisational level is the ontological level, where this study is focusing. At the ontological level or B-organisational level, the actors of the system perform certain performa actions that fulfil transactions that lead to specific results.

Concluding, the POMRS info-logical level supports the POMR ontological level of this study's model. They are both undivided elements of the novel POMR framework also referred as OS. The realisation of this study's organisational theorem requires that all relevant object documentation stored in CLIPS (data-logical level) inform the decision subjects (ontological level) through the supporting information system POMR (info-logical level) in order to form transaction results that will state a service type A as indicated in the ontological parallelogram (see Figure 6.2). The organisation theorem of the enterprise ontology and DEMO methodology is analysed further in the next section.

6.2.2 Devising Info-logical and Data-logical Level Specifications: The Supporting Information System Development.

The patient flow performance scorecards proposed in this supporting information system are the products of the new model's requirements established by the primary research and secondary research results as well as successful patient flow initiatives conducted internationally (see step 4 at Table 4.1). Most of the research has secondary healthcare level as OS kernel, where most of the primary supporting evidence and secondary research efforts exists. The four sets of patient flow scorecards in the supporting information system will provide relevant evidence, at data-logical and info-logical level for the redesigned core patient flow ontological transactions, which are analysed next. The four sets of patient flow scorecards are directly relevant, according to the literature review of this study, to the method's original sets, which aim to evaluate and store processes relevant to financial, internal processing, growth and customer value. Each of these reports includes different measures, which will evaluate and store the OS results. The ontological transactions will provide equal, effective and efficient patient flow in a patient-oriented way if performed at info-logical level and data-logical level according to the following sets of measures. The balanced scorecard approach of this supporting information system is integrated into the ontological model in accordance to the BB model at step 4 (Figure 4.6).

According to enterprise ontology, in order to include these functional measures in the structure of this study's model, coding and parameterisation are in order.
The first report coded as Patient-oriented Measurement Report number one (POMR1) includes four sets of functional measures. The first of these sets of measures will focus on the accessibility function of the healthcare system. Accessibility is a major denominator of an equitable patient flow as it is analysed in this study. It is difficult for a healthcare system, patient-oriented or not, to be effective or efficient if the patients are experiencing difficulties in their access. The next two sets of measures analyse the safety function and structural operation function. Effectiveness of the patient flow is delivered from these two functional sets, as they are responsible for the patient experience. The last set of measures analyses the outcome function responsible for the effectiveness of this flow, regarding patient treatment. It is the only set of measures that is inclusive in relation to the other subset measures of this first report. This means that this set of outcome measures will receive value only if the patient is treated. It is not important if certain of its subset's performance measures are met satisfactorily unless the patient receives treatment.

Ultimately the hierarchy of the sets of measures proposed may vary according to the strategic orientation of each hospital. It might also vary between private or public hospitals. The following measures also focus on the elective patient entities. The weight parameter of each measure will produce the necessary weighted average of the hospital's thresholds necessary for its strategy orientation. The total weighted average result of the healthcare organisations included in this model will be able to monitor the implementation of a NHF.

6.2.2.1 Access measure

This collective type of both specific and generic measure type includes two individual measures that provide patient value-added service and their minimum performance level assures immediate admission:

a. Appointment measure. This measure counts, in days, the time from a patient's initial request for a GP appointment until the time that the patient receives one.
b. The referral measure. This specific measure indicates the GP referrals, for each public or private GP, for patient admitting to secondary healthcare over the total GP referrals for a specified time period. The time period could be set by the country's NHF. This measure shows the number of referrals processed within the healthcare flow at secondary level over the total referrals that secondary healthcare admitted from the "GP" actor. Based on the results of the above measurements, an index is proposed from 1-4 where one equals poor (1=poor), two equals average (2=average), three equals satisfactory (3=satisfactory), four equals Excellent (4=excellent). This measure is directly relevant to budgeting procedures, as the hospitals would have to keep a strict operational budget for each clinic.

c. Safety measure. This collective measure of both specific and generic measure type adds value to patient-oriented service sign (see Figure 6.1), as it prevents harm from healthcare practices. In chapters three and five almost all of the healthcare actors consider safety as the paramount importance parameter for their healthcare services. This set of measures consists of two individual ones following a scale from 1-4.

1. Infection measure. This general ratio is to be measured, in incident units, following the six-sigma philosophy, which, according to the literature review of this study, assures that best practices correspond to zero infection incidents per clinic. The minimum remains to be researched at national level. It is a general measure, as it will focus on infections per general hospital or clinic, and it does not point out the specific doctor's span of responsibility. The aim of this measure is to assist in safer teamwork, according to the novel inflow process of the proposed model.

2. Malpractice measure. This measure also counts, in incident units, the number of malpractice forms completed by patients according to the POMR4 question in patient experience questionnaire. So, if 100 patients filled the questionnaire and only 20 required and completed the malpractice form, this means that there is a patients' perception of malpractices that equals 20%. In order to create a leading measure

rather than a reactive one, this malpractice ratio indicating such practices will be measured counting the number of complaints formed from POMR4 questionnaire, regardless of their legal outcome. The philosophy of a POMR4 is to monitor complaints aiming at the excellence of the patient experience. This measure follows the previous infection measure philosophy of total quality management. According to the free library site (www.thefreelibrary.com/medical+malpractice), a medical malpractice incident is defined as the "*improper, unskilled, or negligent treatment of a patient by a physician, dentist, nurse, pharmacist, or other healthcare professional*. A person who alleges negligent medical malpractice must prove four elements: 1.a duty of care was owed by the physician; 2. the physician violated the applicable standard of care; 3.The person suffered a compensable injury; 4. the injury was caused in fact and proximately caused by the substandard conduct. The burden of proving these elements is on the plaintiff' in a malpractice lawsuit" (Medical Malpractice).

This set of measures is directly relevant to the access set of measures regarding the EPR updated information record measure that could lead to such malpractices.

6.2.2.2 Structure measure

This collection of sets and subsets as well as individual measures, of both specific and generic measure type, associates patient experience to the result versus the cost occurred. It directly relates to the access set of measures result, as they will indicate unnecessary activities that occurred relevant to referral incidents. It also complements the safety measure. Safe and well-structured patient service qualifies for a novel efficient patient-oriented flow.

a. Patient experience measure. This set of measures assures that the patient will have the perception based on the patient satisfaction definition of chapter one that the services received were performed up to the acceptable standards as indicated by NHF. A posterior questionnaire (POMR4) similar to the one used a priori in chapter two of this study will assure that the healthcare organisation resources are providing a satisfactory level of performance. Again the answers will be measured on a Likert scale from 1 to 4 units. This set of measures, like its parent set, will include all values presented in the patient questionnaire proposed. All these measures will indicate the satisfaction level, from 1-4 units. For yes or no type of answers the "yes" answer receives the value of 1 and the "no" answer the value of 0. The value for the question that is related to malpractices is not included in this questionnaire total value result, as it belongs to the previous set of measures. The questionnaire for patient experience is the following:

1. Are you satisfied with the overall services that you received from the hospital?

   Yes______ No_______ Please specify:_________________

2. Waiting time in order to make an appointment with GP or other expert?

   Time: _____ Days Field of Expertise: __________________

3. Waiting time in order to make an appointment for an examination?

   Time: _____Days Field of Expertise: __________________

4. Enough time with GP for treatment explanation?

   Yes______ No____ Specify time frame: _______ Minutes

5. Doctor performed treatment in professional way?
   Yes ____ No_____. Please Specify: _______________________

6. Did you receive an evaluation form? (requested only in a case of potential malpractice)

   Yes____ No____

7. Nurses and Clinical Staff explained treatment/action reasons in an understandable way?

   Yes ____ No_____.

8. Nurses and clinical staff performed treatment in a professional way?
   Yes____ No _____. Please Specify

9. Overall availability of hospital resources?

   Poor___ Average____ Satisfactory____ Excellent____

10. Overall understanding of your medical condition flow paths?

    Poor___ Average____ Satisfactory____ Excellent____

TOTAL POMR4 VALUE_______

Table 6.1: POMR4.The Patient Experience Questionnaire

The above Table of the patient experience questionnaire further analyses the qualitative measures proposed in this framework. This both data-logical and info-logical questionnaire will be coded as Patient-oriented Report number 4 and will be tagged as POMR4. This questionnaire helps the researcher to analyse the exact reasons behind the ratings that the recipient provides in the other framework measures. It also grades the answers with a total cumulative value, which on Likert scale starts from “poor” that equals 1 and ends at “excellent” that equals to 4. All “yes” equal 1 and all “no” equal 0. It is very important that this questionnaire as well as the other set of measures be analysed in proper time and in a manner based on the proposed ontological, patient flow core transactions provided in the following chapter. The above collection of measures that form the performance framework is feasible to be implemented in Greece once the national spine of EPR is in effect.

a. Resource availability measure. The resource availability, measured in hours, will indicate the room availability only and not the bed availability or both. According to the literature review, in most general hospitals in Greece, due to excess of patient population, there are beds in the hospitals’ corridors where patients are hospitalised until they find a proper room. Such practices do not aid in the qualitative progress of the patient orientation of this study, and thus the bed availability measure is excluded.

This individual measure will count the time in hours passed from the doctor’s referral act, according to the novel reference process, until the preparation of safe treatment act of the novel ontological process model.

3. Outcome measure. It is the ultimate inclusive set of individual measures that focuses on results that are based on patient satisfaction. It will receive a rating only if treatment actually takes place. If no treatment is provided at transaction six (T6) of the novel patient flow process model the measure will receive no score on the scale from 1-4 (1=poor, 2=average, 2=satisfactory, 4=excellent). No score indication is necessary in order to avoid phenomena of patients being referred ideally to hospitals available for appointment at secondary level and not to the appropriate ones. The ontological structure of this flow could trace causes of this failure to the root and assist in correcting this serious problem of a patient receiving poor treatment. Then, if the treatment is in order then the following two measures’ results will be required:

a. Service effectiveness measure. It is the measurement of the success rate over the total number of treatment operations performed per general hospital's clinic for patient conditions as referred categorised in the public insurance manuals (IKA manuals).
b. Fair service value measure. The number of ontological acts performed on a patient until the treatment has a successful result. The novel transaction model will provide the exact span of the patient flow that, once measured up to the NHF standards the sign of this study, will be defined as patient-oriented. Ontology structure of the patient flow will assist towards such an objective. Practising valid benchmarking methodologies at international level, although possible from the proposed ontological model, is beyond the scope of this study. In order for patients to exercise the necessary degree of control they have to participate in healthcare decisions that directly affect them. The choice criteria or thresholds could be set by the NHF.

The following comparable info-logical level report (POMR1) shows an indicative patient satisfaction measure result for three different HCOs. Based on this report cohesive benchmarking practices focusing on patient satisfaction could be implemented when the doctor consults patients for further treatment. All of the proposed reports, including the following two versions of POMR1, should be available to the necessary medical stakeholders' at every transaction of the patient flow according to their access rights to this reporting system. This study, according to its concept, indicates specific results necessary for each ontological act (see Table 6.7) so that the actor "patient" makes an informed decision for his/her flow through the healthcare flow. The complete availability structure for the healthcare stakeholders' access rights to this reporting system is beyond the focus of this study. It is also possible that the weights column in the following Table could vary according to the HCO's strategic management. For the public sector, a central directive could provide cohesive thresholds placing specific weight on these values in order to facilitate benchmarking processes with other countries if necessary. All sets of measures will be assigned to the Actor Transaction Diagram (ATD) of the redesigned processes as well as to transactions with the necessary results that have to be measured. In this way the applicability of each redesigned transaction will be measured according to its span and the result it is expected to deliver. Once the ATD diagram is analysed according to DEMO methodology, weight values could be assigned to the measures proposed. Once again, in the public sector, such external environment practices are relevant to the national political and strategic environment of each country and are beyond the scope of this study.

General Hospital Values	A	B	C	Weight
Access Measurement	4	4	3	
Safety Measurement	4	2	1	
Structure Measurement	4	3	4	
Outcome Measurement	2	1	2	
Total Measurement	14	10	10	

Table 6.2: POMR1 Comparable Report. Patient Condition Collection Measure Comparable Report

According to the above Table, it is evident that general hospital A is the most appropriate for hospitalisation, as it has the best score. This info-logical level report will be coded as Patient-oriented Measurement Report number 1 and will be tagged as POMR1 comparable report. Thus, the weight given to each set of measures could directly affect the total result (weighted average) of this Table. The proposed ontological structure will assist in creating a coherent logical and integral flow that will require concise performance measurements to define such flow as patient-oriented. It is, therefore, possible for future accreditation institutions to monitor, through benchmarking functions, transactions and transaction measurements that would ultimately deliver the required service type results. Due to its dynamic nature, this collective measure of patient satisfaction adapts appropriately to the competitive environment of any healthcare industry. It depends primarily on the system’s reaction relevant to the patient’s condition, based on the external environment. The external environment is an integral part of this measure through the weight that is attached to the above POMR1 report. This comparable report POMR1 will be delivered at transaction T06 of the proposed ontological structure to the healthcare administrators through the “call centre” actor of this model. The aim of this info-logical level report is to evaluate the patient orientation of each healthcare organization on a national basis. In this way, the cumulative value of all the patients exiting the healthcare flow could be stored and researched and evaluated accordingly. The patients are not the recipients of this report, as they are aware of the measures disclosed in this report at an earlier transaction (T03). Effectiveness is the most important element in this patient satisfaction collection of measures. Thus, all the data provided from the previous set of measures and questionnaires receive value, from 1 to 5, through this set of outcome measures to the patient, value-added service equation, once treatment is performed (see Table: 6.4: POMR2). The inclusive nature of this outcome measure is necessary, as the proposed OS and the designed measurements framework functionally monitor patient orientation and could have serious problems if patients experience this healthcare flow efficiently but without treatment. If this ratio receives no value, that means that there are serious external parameters at the national level (political, social, technological, and legal) that have to be redesigned as the entire patient value-added service that underscores the patient-oriented flow of the system designed will value zero. Although such redesign of the external environment is indicated through this measure, it is beyond the aim of this study.

The service effectiveness sub-measure of this outcome set of measures once the patient is treated indicates the success rate over the total number of operations performed. For example, based on the diagnosis process of an orthopaedic doctor, there are three operations that have to be performed on a patient’s lower torso in order to permit walking again. The final number of operations performed is six, twice as many the diagnoses indicated. Although treated, the patient could require information from the doctor in order to justify the doctor’s methodology as well as the overall understanding of this “patient condition” instance. Both questions are indicated in the patient experience questionnaire. In this way, if healthcare stakeholders consider that the effectiveness ratio is high as it holds the value of two (operations initially diagnosed / final operations performed = 3/6=2) they could further proceed to the questionnaire to detect any complaints. If there are no complains in effect, the process could be assumed as patient-oriented. On the other hand, it is for the healthcare system to justify the right medical methodology if it detects that this high ratio value tends to be a habit of some doctors. Thus, this ratio’s rationale is first to quantitatively assess the degree of the treatment effectiveness, and in coordination with the patient experience questionnaire the qualitative factor could be further examined to detect patient orientation.

The next measure of fair service value, on the other hand, evaluates the total number of administrative transactions until the patient exits the healthcare flow. Both measures underscore the load of both medical and administrative transactions that a treated patient had to face through this healthcare flow. At the data-logical level, the discharge documents together with the hospital bill could provide the necessary documentation. The discharge documents verify that the patient is healthy and could exit the healthcare institution. The hospital bill should be an itemised list of medical transactions that occurred during the patient's flow. This measure together with the other sets of measures could prove the efficiency of the patient flow as well as its effectiveness. If the number of transactions that occurred is more than the hospital expected for the medical condition type, then it is obvious that there is an unreasonable overhead cost for the services provided. It is for the healthcare organisation to further proceed and evaluate, based on indicated thresholds, if treatment was provided according to the diagnosis transaction. If treatment is in order, which means that the measure collection holds a specific value, then qualitative and quantitative sets included in the collection require further analysis. The following Table summarises the above measurement's sets:

ACCESS MEASUREMENTS SET

1. APPOINTMENT MEASURE = TIME PASSED FROM INITIAL APPOINTMENT REQUEST TO APPOINTMENT ARRANGEMENT
2. REFERRAL MEASURE = REFERRALS/ADMISSIONS

SAFETY MEASUREMENTS SET

3. INFECTION MEASURE = INFECTIONS OCCURRED/TOTAL ADMISSIONS (inpatient, outpatient count)
4. MALPRACTICE MEASURE = MALPRACTICE COMPLAINT FILED (see Table 8.2, questions 5 and 6) / OPERATIONS PERFORMED

STRUCTURE MEASUREMENTS SET

5. PATIENT EXPERIENCE QUESTIONNAIRE VALUE (POMR4 VALUE)
6. RESOURCE AVAILABILITY MEASURE = TIME OF THE ROOM ASSIGNMENT – TIME OF ADMITTANCE (In Hours)

OUTCOME MEASUREMENTS SET

7. FAIR SERVICE EFFECTIVENESS MEASURE = TOTAL TREATMENTS / TOTAL OPERATIONS FOR TREATMENT
8. FAIR SERVICE MEASURE = NUMBER OF ONTOLOGICAL ACTS OCCURRED PER TREATED PATIENT

Table 6.3: The Exploded Patient Condition Measure Collection Report (POMR1 Exploded Report)

This fully exploded report is a variation of the previous POMR1 comparable report. The patient receives the comparable version of this report at T06 proposed ontological transaction. This report at info-logical level could assist “GP” actors and medical experts in their quality patient consultation for further treatment. This is the main reason that both of these report variations receive the same alphanumerical code. The aim of this report is to assist in flow efficiency. Concluding, the creation of the actor “patient” as the ultimate judge of the healthcare system rather than an aware system actor with the right to make an informed decision is outside the purpose of this study.

The proposed optimal goal of this study’s concept is incorporated in the patient value-added proposition next. The patient value proposition is defined as the necessary set of healthcare service values to achieve patient treatment and satisfaction in healthcare flow. The patient value-added service consists of two parameters:

- <u>The patient condition collection of measures value.</u> These measures encompass the patient quality parameter based on the patient needs and values encompassed in patient flow transactions. This collection of measures is mostly relevant to the internal healthcare environment as it provides the necessary data for an HCO patient centred orientation or potentially a required accreditation. It also provides the necessary data for effective patient relationship management and treatment through the novel core ontological transactions (T01 to T06) presented in the next chapter.
- <u>The HCO accreditation value.</u> The accreditation measure reflects the necessary intangible parameters that a healthcare system should have at all organisational levels (ontological, info-logical, data-logical) in order to provide quality service. The accreditation parameter, especially at info-logical and data-logical level, is important, as it directly relates to the external healthcare environment providing the necessary measures for quality patient flow services. For the purpose of this study and due to the nature of the Greek healthcare industry, the flow’s kernel will be the general hospital, and the only accreditation required will be the security in patient data, which is legally required by the European Union.

Thus, the following info-logical report of the POMRS system of balanced scorecards is the patient value-added service formula. The POMR2 report will accompany the initiation of the patient relationship management transaction (T01) result. It is the only report that possesses a single specific value per healthcare organisation. This report is delivered to the patient at transaction T03 together with POMR3 and is a simple, understandable rating evaluating a hospitals’ performance. When the doctor diagnoses a patient for further treatment the patient should be aware, from CLIPS database, of the POMR2 historical value record of the hospitals proposed and decide accordingly. The patient value-added formula represents a patient condition that can be expressed as follows:

Patient Value-added Service = POMR1 total value + Health Care Organisation's Accreditation Value from patient's data security EEC directives

Table: 6.4: POMR2. Patient Value-added Service Report

The patient condition collection of measures presented in this equation is further analysed in the next section. This report will be coded as Patient-oriented Report number 2 and will be tagged as POMR2, and it will be issued per hospital as the previous report POMR1. It is an important info-logical level formula, as it reports most of the values that patients request based on primary and secondary research and equals the sum of patient satisfaction and treatment values. The POMR1 total value comes directly from the previous report. The POMR4 total value is included in the POMR1 exploded report total value and comes from the patient experience questionnaire (see Table 10.1: POMR4.The Patient Experience Questionnaire). The fair service value, also included in the POMR1 exploded report could come from the number of acts delivered from the novel ontological structure of the patient flow produced next.

Finally, the accreditation parameter links the internal environment, expressed through the POMR1 collection of measures, with the external environment that secures patient data and is relevant to the national healthcare policy of each country. As presented in the literature review and according to the CEN/CENELEC Internal Regulations, the national standards organisations are bound to be implemented by most of the European Countries. This European Standard was given the status of a national standard in September 2007. This agreement supports the disclosure of the electronic healthcare record (EHCR). This communication, whether at national or even international level, has to be secured (ISO/TC 13606-4, 2007). So, it is for the NHF to assist HCO towards the signature of this agreement. Data security is of critical importance for this formula, as it incorporates measures related to the time, quality and price dimensions, to secure all data analysed. Thus, the HCO's that carry this certification at national level should receive the value of 1. Initially, as Greece has not yet complied to this agreement, this formula will carry the value of 0. At the same transaction T03, as mentioned above, the Patient-Hospital Performance Report (POMR3) will also be provided. This proposed report provides the patient with a clear recent historical picture of the system's organisational structure. It is available for every patient entering through T01 core process and exiting through T06 core process indicating the following measures:

1. POMR1 Value
2. Service Effectiveness
3. Fair Service Value Measure
4. Room Availability

Table 6.5: POMR3.The Patient-Hospital Performance Report

This report, which will be produced per hospital, is coded as Patient-oriented Report number 3 and will be tagged as POMR3. Some of the system patients might have chronic healthcare problems, others not. Depending on their status this info-logical level report could introduce a series of transactions that will be in accordance with the national healthcare strategic framework initiated by transaction one (T01). Thus, the patient that enters the system could receive, through the ontological model introduced, an initial status report thought transaction (T03) that is the data-logical document of doctor's referral. The info-logical report (POMR3) will be provided as a decision support tool that will aid the patient to consider, if necessary, the flow based on the doctor's referral document. The seriousness of such an act is denoted through the secondary transaction type T10, which is the analysis of the patient-oriented measurements for T03 core transaction (see TRT Table 6.7). These info-logical reports stored at data-logical level in CLIPS knowledge base could accumulate values and introduce the accumulated results of similar patient conditions over the years per hospital. Then, the patient flow transactions will be evaluated by the NHF, based on the patient condition collection of measures metadata analysis, for every hospital assisting in the implementation of the patient-oriented concept of this study. Finally, the performance reporting system (POMR system) realised at data-logical and info-logical level is based on the above supporting information system of balanced scorecards. This balanced scorecard system reports the values of the relevant measurements for each ontological act, transaction or process produced next according to DEMO methodology's BB model. This balanced scorecard's system based on the ontological model of the patient flow secures the patient-oriented flow function. The relationship between the ontological transaction structure produced and the performance reporting system function proposed is exhibited in the following figure:

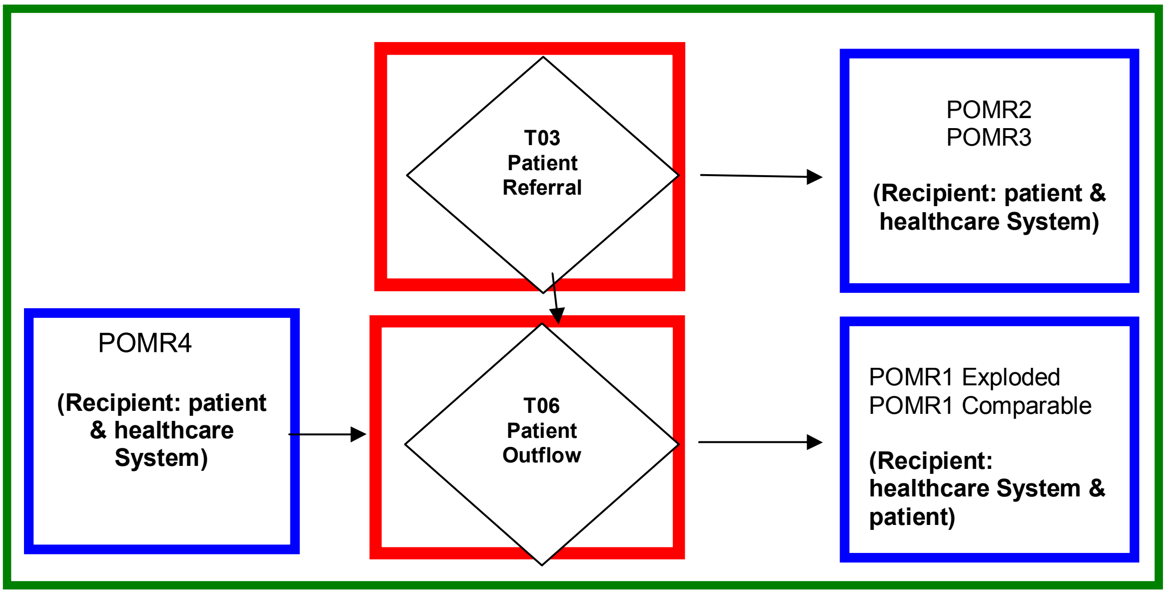


Figure 6.4: The Data-logical and Info-logical reporting Flow (POMRS)

Specifically, according to the above figure, as the patient enters the healthcare flow at T03 core transaction, a diagnosis occurs through the secondary transaction T09. At this point of T03 execution, the patient is eligible, according to the process model rules (see appendix 1), to receive the patient-hospital report (POMR3). This info-logical report as exhibited in Table 10.5 is based on this study's novel ontological structure. It functions as a tool that shows the results of the POMR3 that the GP proposes for patient value-added treatment expressed in relation to Patient Value-added Service Report (POMR2) at the Table 6.4.

As the treated patient exits the system at T06 transaction, according to the result structure chart of the proposed patient-oriented flow (see Figure 6.5), the report tagged POMR1 will be delivered encompassing the cumulative on-line updated scores from CLIPS knowledge base including the exact patient's condition quality data. This POMR1 exploded report version is for the health care administrators, as the POMR1 comparable report is for the patients, who will receive it through the ontological structure's "call centre" actor's CLIPS database as an updated data-logical historical record. All system actors could be aware on-line of the progress made towards the aim of this study. Healthcare administrators will also receive report POMR4 which will help them to research more qualitatively the results accumulated through the POMR1 exploded report. On the other hand, the patient will be aware of the service level that was implemented during this healthcare flow by receiving the POMR4 historical data at the exit transaction T06. The POMR1 comparable report is not provided to the patient at inflow transactions, since, according to the action rules (see appendix 1), it is the doctor's responsibility to propose the best hospital for patient condition type.

These two reports (POMR1 and POMR4) are in accordance to the span of responsibility produced through the ontological transactions of the C-world and the concept of this study. The novel patient-oriented flow model will be in direct relation from the scorecards functional results for every patient condition-type entering the ontological model. Thus, this POMRS function, according to the organisational theorem (Dietz, 2006), is the data-logical and info-logical level of support for the POMR ontological level of this study's model. They are both undivided elements of the novel POMR framework also referred as OS as the next figure exhibits:

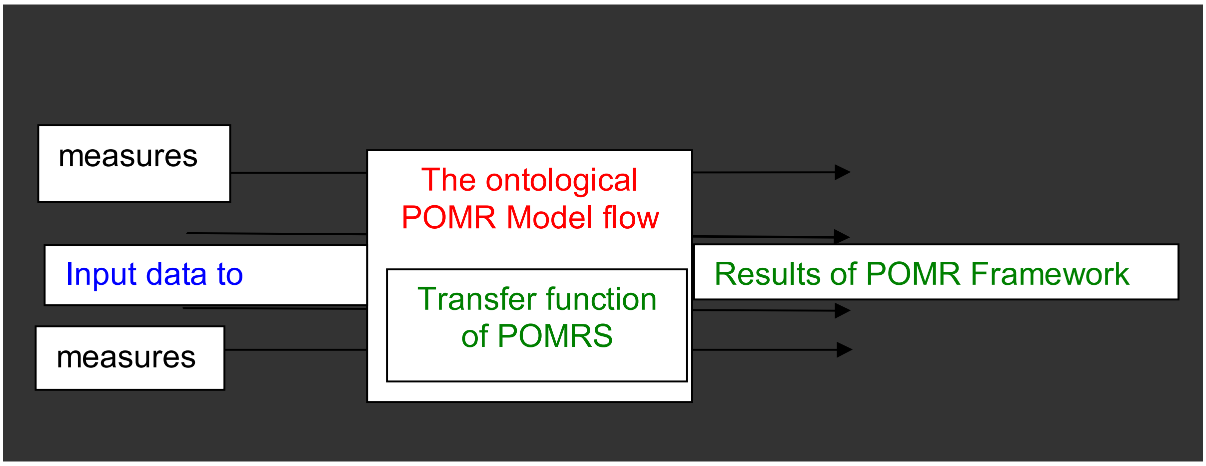


Figure 6.5: Representation of the Black Box model of POMRS

According to the representation of the Black Box model, the input data at data-logical level when transferred at ontological level through the indicated ontological process model results in the info-logical level which will support both patient and healthcare administrators to produce a patient-oriented service type flow. These performance framework values should be acknowledged, as they indicate performance levels of the specific patient condition-type. For example, the patient on POMR3 will focus on more specific measurements generated in this report. The time necessary for receiving a proper room in a hospital is one of the major parameters in deciding the general hospital to be referred to. At the same time the value-added service formula (POMR2) for that hospital might outweigh long waiting times in favour of a better service. That is why patients receive this report at an early stage of this flow (T03). In that way, they could decide together with their doctor the best treatment route to be followed.

On the other hand, an over-explicit info-logical exploded report POMR1 if provided to the patient entity will not add value to the patient flow but rather create difficulties. The rationale behind this info-logical and data-logical performance system is to provide value by empowering patients and not puzzle them. With such an approach, it is easy to understand the cumulative scores of these reports on a Likert scale. Thus, the patient at an exiting transaction T06 receives a summarised comparable hospital report (POMR1 comparable) in order to complete the whole service type picture.

The overall score of each healthcare institution included in the reports (patient-hospital report, patient condition collection of measures report and finally the patient value-added treatment report) could serve as a benchmark for redesigning the NHS. It is also a simple and clear indicator for every system's stakeholder in an effort to understand the level of healthcare delivered. Through these balanced scorecards, they could derive evidence for ontological actions stored in CLIPS based on the info-logical and data-logical level in order to improve the healthcare model towards the aim of this study.

Finally, this reporting system generates a direct relationship among the NHF, the framework's concept and the weak points that have to be improved based on the ontological model that follows. So, every act generated in this flow by the system's actors could be measured from this supporting information system, and the results available could be stored in CLIPS for strategic evaluation. Finally, these values according to this study's model are disclosed, on a need to know basis, to every system's actor based on the ontological structure presented next.

At info-logical and data-logical level, this performance reporting system is oriented a priori towards patient needs, as it is parameterised according to the OS of this study (see Table 6.5: POMR3). On the other hand, as a contingency plan, the patient experience questionnaire is not a quantitative report but a qualitative one. It focuses on qualifying the results accumulated through the above quantitative performance reporting framework. Finally, the BB model implementation through the CLIPS program stores the results of the WB model structure and serves as a field for the system actors in order to understand tactical goals that have to be generated from every patient instance entering the healthcare flow. The POMR4 questionnaire report provided should fine tune the quantitative reporting performance framework and could serve, as this study's primary research questionnaire, in understanding immediate corrections that have to be administered. In addition to all that, Greece should comply with the standard data security directive in order to guaranty the security of the patient data. If an institution or national healthcare system has security problems, then the value of a Health Care Organisation's Accreditation on EEC's patient's safety will change to 0 (see Table 10.5: POMR3). There will be no intermediate value, as there are many legal implications relative to this parameter. The exact security process could vary and has to be implemented at national level by European authorities. Although such processes are very important they are beyond the scope of this study, as they belong to the external environment's political and legal parameters as analysed in the literature review. Thus, the value of the patient value-added service report will receive accreditation value of 0 or 1 from the national healthcare system according to the European directives for security.

According to this study's literature review, as of 2002 a USA based Agency for Healthcare Research and Quality (AHRQ) is sponsoring the development of National Quality Measures Clearinghouse, NQMC, a significant enhancement to the Agency's CONQUEST library of performance measures, in order to promote widespread access to quality measures by the healthcare community and other interested individuals (National Quality Measures Clearinghouse, 2006). Based on the publicized criteria of NQMC, this section will further analyse the collection of measures presented. This further analysis starts by defining what these four different sets of measures (access, safety, structure and outcome) include and their rationale as well as their mutual inclusiveness or exclusiveness.

The first set is the access measure, which is both a qualitative and quantitative measure. It is nominated for inclusion due to its importance, scientific integrity and feasibility. Based on the primary research and literature review, the equal access to healthcare in Greece is a democratic right that every Greek citizen possesses. So it is very important that the effectiveness of this access be measured. For this reason, the access measures set is analysed into two subsets: the appointment and the referral measure (see Table 6.3). The rationale of the appointment measure is to count the time passed for a patient from the initial appointment request to the 1535 line. It is important to mention that theoretically, at least, there is no need for elective patients' walk ins in Greece, as this service could be provided over a national call centre through the national healthcare line number 1535 (http://www.mohaw.gr).

The rationale behind the referral measure (see Table 6.3) is to count the number of patients with referrals over the total number of patient admissions. The reason for the patient to be referred to a secondary healthcare institution is to optimise patient continuity of care through an efficient and effective healthcare system that satisfies the patient (Batterham et. al., 2002). It is also important in order to count this category's contribution to the total patient flow at this level. A more qualitative measure is also the number of referrals per GP to a specialist that proceeds with further treatment (both inpatients and outpatients) over the total number of GP referrals per HCO. If this ratio shows a high percentage of unnecessary referrals from specific GPs, then the EPR record should be checked in an effort to understand potential lack of updated patient information that led to such an issue. The next set, the safety set of measures, includes the malpractice and infection measures (see Table 6.3). It is not acceptable to refer a patient for further unnecessary examinations or even hospitalisation, as such an action not only endangers the patient condition but it also overloads flow paths irrelevant to the patient's treatment. According to primary research, in his interview, Dr Elefteriades claims that such heavy circulation paths might be of vital importance to patients that really need them. The malpractice ratio is also in effect inside the hospital facilities with the same logic. Due to the legal implications, cases of malpractice are proactively monitored through the forms of complaints which are issued in the patient experience questionnaire that is included in the next set of measures. Infections are also important and have to be monitored as a percent of the total operations performed per hospital facilities, as often it is possible that more than one clinician is responsible for such issues.

The structure set of measures is necessary in order to proceed with the secondary or even tertiary flow in some cases (see Table 6.3). Resources availability and specifically beds and exam technology are very important for a patient's healthcare (Tanner, 2008). A "patient" actor that has to wait long for further examinations is subject to potential health problems depending on its "patient condition". It is also very important to count the time frame required for a bed reservation, regardless of the room size, which is a necessary condition for any type of operation (www.mahaw.gr). Usually, this ratio, as analysed in this study's literature review, deals with the lack of patient satisfaction that could be expressed through the patient experience questionnaire. This questionnaire is relevant to problematic areas, which, based on primary and secondary research, are necessary to be improved in order to satisfy the patient flow. All the other measures' inputs could be provided by the healthcare stakeholders, at the data-logical implementation stage, as they require a basic electronic infrastructure that is available to all healthcare institutions in Greece (see Figure 6.4)

In conclusion, the formulation of a supporting information system of measures (POMRS) at info-logical and data-logical level is important, as, at the ontological level, it supports the patient satisfaction and redesigned treatment framework (OS). This supporting information system generates results based on the BB model function presented (see Figure 6.5). Both the BB model and the WB model of DEMO methodology adopted for this study's conception provide a solid scientific basis instead of a trivial proactive measures aggregate sum. The supporting information system's collection of measurements at data-logical and info-logical level relates directly to both the internal and external healthcare environment. Thus, this redesigned ontological framework could provide a basis for the common understanding of this study's conception among different medical disciplines and healthcare organisations that potentially may have extremely diverse cultural backgrounds. Finally, at data-logical and info-logical level, this functional information system will be used for measuring the core transactions accumulated at the ontological level. Thus, according to the organisational theorem (Dietz, 2006), at the data-logical and info-logical level, the supporting information system forms the new framework's basis for implementation of this study's concept at ontological level. Thus, this POMRS, according to the organisational theorem (Dietz, 2006), is the data-logical and info-logical level support the POMR ontological level of this study's model. They are both undivided elements of the novel POMR framework also referred to as OS. Ontology will clearly and universally define both the concept of this study as well as the necessary transactions needed for a patient-oriented model flow. Thus, the enterprise theorem of ontology presented earlier in this chapter ensures the right framework for the implementation of the patient flow measures proposed. Next the adopted methodology step 6, (see Table 4.1 and Figure 4.6), which includes DEMO methodology construction and synthesis based on DEMO techniques, will be analysed.

6.3 The OS Redesign

Based on Wolstenholme's patient flow (Wolstenholme, 1999) and a primary and secondary research conducted in northern Greek Hospitals a proposed patient-oriented framework is generated. According to the human abilities distinction axiom and the organisational theorem, a performa, informa, forma analysis will follow (Dietz, 1999). These DEMO techniques will assist in this OS design and process measurements that will evaluate the efficiency, the effectiveness, and the social issue of an accessible healthcare system. This step 6 of the adopted methodology is the reengineering of enterprise ontology for the OS construction, analytical synthesis towards a new framework implementation with the assistance of a complete supporting information system design, exhibited in the next chapter. At this step, the

following DEMO tools presented in Table 6.6 for the step 6 of the adopted methodology for analysis and synthesis will be designed:

1. Performa-Informa-Forma Analysis
2. The Coordination-Actors-Production Analysis
3. The Transaction Pattern Synthesis
4. The Result Structure Analysis
5. The Construction and Organisation Synthesis

Table 6.6 DEMO Methodology design and Synthesis Tools

6.3.1 Performa-Informa-Forma Analysis

The elective patient flow, proposed in this study, starts when the patient entity enters the healthcare system. The following process represents the human abilities distinctions in colour and the organisational theorem for the restructured patient flow. The process model that follows will analyse all the restructured transactions of this process flow step by step. At this point, an overview of the proposed, future elective patient flow subject to the NHS structural analysis is the following:

Patients announce themselves to the GP secretary/call centre. Patients request an appointment. Then the GP reads information from the patient record through the National Healthcare System central spine. The GP reads the patient's record (EPR), requests a further examination if necessary. Then, once the appointment is set by the secretary/call centre, the GP reads all the requested exams and performs the examination. When the GP delivers the examination results, both GP and patient scan a relevant patient hospital report for certain treatment routes to follow. Irrespective of the route, the GP has to inform the elective patient about the potential routes that he could be chosen advising on the relevant patient hospital report based on the diagnosis.

The potential patient flow routes, which are also relevant to these performance ratios' report, are the following:

1. Condition advice with medication reference
2. Minor GP surgery
3. Reference for further treatment at secondary level
4. No further treatment. Patient exits system. Completes a patient experience questionnaire evaluating performance**.** The patient delivers the report to the healthcare organisation (HCO) from where he/she exits system. Then, the organisation delivers to NHS the patient condition collection of measures report once a year.

All routes are available on the system's list. The doctor informs and interprets these performance ratios measuring relevant POMR figures and patient treatment horizon and success rates presented in the patient hospital report. The informed elective patient now has to fill out a declaration of understanding form together with the GP for the decision taken regarding the optimal treatment route.

The patient enters the hospital and is informed of resources availability and track record based on patient hospital report. If the patient is informed that there is not any satisfactory resource availability on the hospitals records, the patient has to wait or leave. If the patient is informed from the hospital's records that there is satisfactory availability, then the patient follows a treatment process. The patient is monitored, diagnosed for the right treatment or surgery, prepared for surgery and finally monitored again after treatment or surgery by the [clinicians] and the [doctors].

If the patient remains unhealthy he/she enters rehabilitation at the third level until he/she is treated by clinicians or else exits (mortality issue or healthy issue) the system.

The patient completes a patient experience questionnaire, and the patient hospital report. The patient delivers the report to the healthcare organisation (HCO) when exiting system. The healthcare organisation then delivers the patient condition collection of measures report to NHS once a year. This information is available at all levels of healthcare.

The above flow process overview of the proposed patient-oriented flow focuses primarily on the ontological transactions, which will be analysed next. For a complete overview of this flow, the coordination actors are also important. Thus, the coordination-actors-production analysis that follows needs to be analysed and examined.

6.3.2 The Coordination-Actors-Production Analysis

The coordination-actors-production analysis has to be performed based on DEMO methodology. In this tool, the actors who have roles and authority are defined by “[“ “]” in text or in processes’ diagrams presented next by an ellipse. The production requires competence of the actor and is defined by “<” “>” or in diagrams presented by a diamond. Finally, the coordination world that implies responsibility is defined by “(“ “)” or in the diagrams by a circle. The above schemes will also aid, in addition, in the construction of the following patient flow model, in the supporting information system (POMR) introduced in the CLIPS program. The authority and responsibility as well as the production represent the exact critical success factors required for the purpose of this study in chapters one and three. The actors, besides elective patients, according to free dictionary definitions (http://www.thefreedictionary.com/) include:

1. The medical doctors also described in this study as doctors.

2. The clinicians which “health professionals like a physician, psychiatrist, psychologist, or nurse, involved in clinical practice, as distinguished from one specializing in research”.

3. The GP’s “have particular skills in treating people with multiple health issues and comorbidities”. They are considered in this proposed flow as the gatekeepers of the system. In Greece they are often defined as family doctors or pathologists.

4. The medical experts or specialists that are following serious medical issues. The patient when admitted with a serious or peculiar medical issue to a healthcare organisation is usually under the care of a special consultant (in this study, medical expert) relevant to the type of the medical issue in concern.

5. The definition of rehabilitation personnel is a very sensitive matter in Greece. According to the Medical Anthem the job description (www.anthem.com/medicalpolicies/guidelines/gl_pw_a051175.htm), such rehabilitation services occur “in the outpatient setting”. They are “those services, furnished pursuant to physician orders, which require the skills of qualified technical or professional health personnel such as registered nurses, licensed practical (vocational) nurses, physical therapists, occupational and therapists” (Clinical UM Guideline, 2010).

6. The Secretary/Call centre actors possess critical communicative and secretarial skills.

Then, based on the following actor’s span of activities, performance measures could evaluate the degree of the patient orientation for every transaction and process of the following proposed flow:

[Patients] (announce) themselves to the [secretary/call centre]. [Patients] (request) an appointment. Then the [GP] reads information from the [Patient] record through the NHS central spine. The [GP] reads the [Patient’s] record (EPR) <request> for further examination if necessary. Then once the appointment is **<**set> by the (secretary/call centre) the (GP) reads all the requested exams and <performs> the examination. Then the [GP], when patient’s appointment is <set>, (delivers) the examination results. Both [GP] and [Patient] scan the proposed patient hospital report for possible treatment routes to follow. Irrespective of the route, the [GP] has to inform the elective [Patient] about the potential routes that [he/she] could choose advising on the relevant patient hospital report based on the <diagnosis>.

The potential [Patient] flow routes relevant to this relevant patient hospital report are the following:

1. Condition advice with medication reference
2. Minor [GP] <surgery>
3. Reference for further <treatment> at secondary level
4. No further <treatment>. [Patient] <Exits> system. <Completes> a patient experience questionnaire <evaluating> performance. The [Patient] <delivers> the report to the (HCO) from where he/she <exits> system. Then the healthcare organisation delivers to (NHS) once a year the patient condition collection of measures report

All routes are available on the system’s list. The [GP] informs and interprets these performance ratios <measuring> relevant POMRS figures and patient treatment horizon and success rates. The informed elective [Patient] now has to fill out a declaration of understanding form together with the [GP] for <deciding> regarding the optimal treatment route.

The [Patient] <enters> the hospital and is informed regarding resources availability and track record based on patient hospital’s report. If the [Patient] is informed that there is not any resource availability on the hospital’s records, the [Patient] has to <wait> or <leave>. If the [Patient] is informed from the hospital’s records by a [clinician] that there is availability, then the [Patient] <follows> a treatment process. The [Patient] is <monitored>, <diagnosed> for the right <treatment> or <surgery>, >prepared> for <surgery> and finally <monitored> again after <treatment> or <surgery> by the [clinicians] and the [doctors].

If the [Patient] remains unhealthy <enters> rehabilitation at the third level until he/she is <treated> by [clinicians] or else <exits> (mortality issue or healthy issue) the system.

The [Patient] <completes> a patient experience questionnaire <evaluating> performance through the patient hospital report. The [Patient] <delivers> the report to the (HCO) when <exits> the system. The organisation then delivers the patient condition collection of measures report to (NHS) once a year. Information is available at all levels of healthcare.

The transaction pattern synthesis that follows will indicate the acts and facts of the OS that indicate the actor responsible for each act. The transactions represented next will provide the necessary acts and the results of the specific facts when implemented.

6.3.3 The Transaction Pattern Synthesis

The result of this synthesis is the assignment and specification of the result accumulated from each transaction. The results of each transaction are very important OS requirements, as they are the ones that will be evaluated in order to measure the degree of the patient-oriented concept performance indicated by the ontological parallelogram of the previous section (see Figure 6.2). The transaction types are numbered according to the OS requirements and indicated in accordance with the contemporary structure presented in the previous chapter as follows:

T1 Healthcare appointment request

T2 E P R analysis

T3 Doctor’s referral for further treatment

T4 Hospital inflow

T5 Hospital discharge and/or rehabilitation treatment initiation

T6 Patient relationship monitoring

T7 Patient record management

T8 Information retrieval from NHS bill of examination database

T9 Patient examination

T10 Patient-oriented measurements analysis for patient condition

T11 Initiation of patient’s treatment circle

T12 Electronic study management treatment

T13 Proactive treatment

T14 Doctor's expert opinion

T15 Laboratory tests

T16 Clinical tests

T17 Electronically recorded treatment performance

T18 Treatment narration of methodology

These proposed transactions redefine the WB design, demanding proposed basic, patient-oriented, structure results, regardless of the functional framework produced with the BB design at the info-logical level and data-logical level. The objective of the above transactions is to clearly define the quality result that has to be measured at the primary transaction level. The performance level of the proposed result that will be exhibited next will be measured with the support of the information system proposed. At this point, a result has to be assigned to each transaction for the ontological level of this model. In addition to the contribution of the info-logical and data-logical level to the primary ontological transactions, certain secondary transactions of the following structure chart will show the need for the performance framework interactive assistance in measuring the patient-oriented flow level of the indicated primary results. Secondary transactions are part of the primary transactions and necessary according to the value chain approach for the implementation of the OS.

6.3.4 The Result Structure Analysis

The accumulation of the Transaction Result Table (TRT) will link the results to the transactions, and then the following chart will clarify the hierarchical relationship between transactions types and their results. These transactions are bonded in the previous ontological coloured reports of the patient flow process (Bunge, 1977). These bonds assist in the proper measures collection and represent the OS requirements of the previous methodology step (see figure 4.6). The Action Transaction Diagram is the proposed future step of the redesign analysis, as it encompasses certain new novelties and serves as a field for redesigning the necessary processes and transactions for the process model of the patient-oriented flow that follows. The result structure chart of the patient-oriented flow specifies the exact hierarchy of the future proposed step of the redesigning methodology presented in the literature review. It hierarchically maps the final structure of the necessary six core processes and their sub-processes, and, thus, it uniquely identifies through transaction one the patient entity in the centre of all the processes. Mapping the system process will help in assessing the necessary OS. A concrete visual is a model of a conceptual system that it is called system's implementation (Matthew and Clarke, 2004). The Transaction Result Table (TRT) that follows will assist in completing the above proposed ontological model properties:

TRANSACTION TYPE	RESULT TYPE
T1 Healthcare appointment management	R1 Initiation of a patient relationship management
T2 E P R analysis	R2 Complete patient record
T3 Doctor's referral for further treatment	R3 Patient treatment proposal based on POMR2
T4 Hospital inflow	R4 Patient-oriented hospital registration and room allocation
T5 Hospital discharge and/or rehabilitation treatment initiation	R5 Patient treatment and/or outpatient hospital rehabilitation procedures report program
T6 Patient relationship monitoring	R6 Verification of rehabilitation procedures and delivery of POMR1, POMR4
T7 Patient record management	R7 Storage, indexing, retrieval of patient records
T8 Information retrieval from NHS bill of examination database	R8 Interpret information based on Expertise
T9 Patient Examination	R9 Diagnosis of the patient's problem
T10 Patient-oriented measurements analysis for patient condition	R10 Treatment proposal based on relevant POMR3
T11 Initiation of patient's treatment circle	R11 Patient POMR based counselling
T12 Electronic study management treatment	R12 Electronic verification of treatment process and medical operations
T13 Proactive treatment continuation	R13 Prevention plan.
T14 Doctor's expert opinion	R14 Patient quality communication
T15 Laboratory tests	R15 Safe laboratory results
T16 Clinical tests	R16 Safe clinical results
T17 Electronically recorded treatment performance	R17 Patient's awareness of medical Performance
T18 Electronically recorded narration of treatment methodology	R18 Patient's awareness of the full treatment circle

Table 6.7: The TRT of the Proposed Patient Flow

Lists of dependent results associated with the above transactions are identified in the following result structure analysis. Every transaction has to create a specific result which is exhibited above. The reason behind this chart is the proper formulation of the patient-oriented flow by accumulating specific results that will be measured through the supporting information system. The proposed results' relationships are based on contemporary patient flow which are enriched by certain novel transactions as well as a hierarchical restructuring, which are also presented in the next figure:

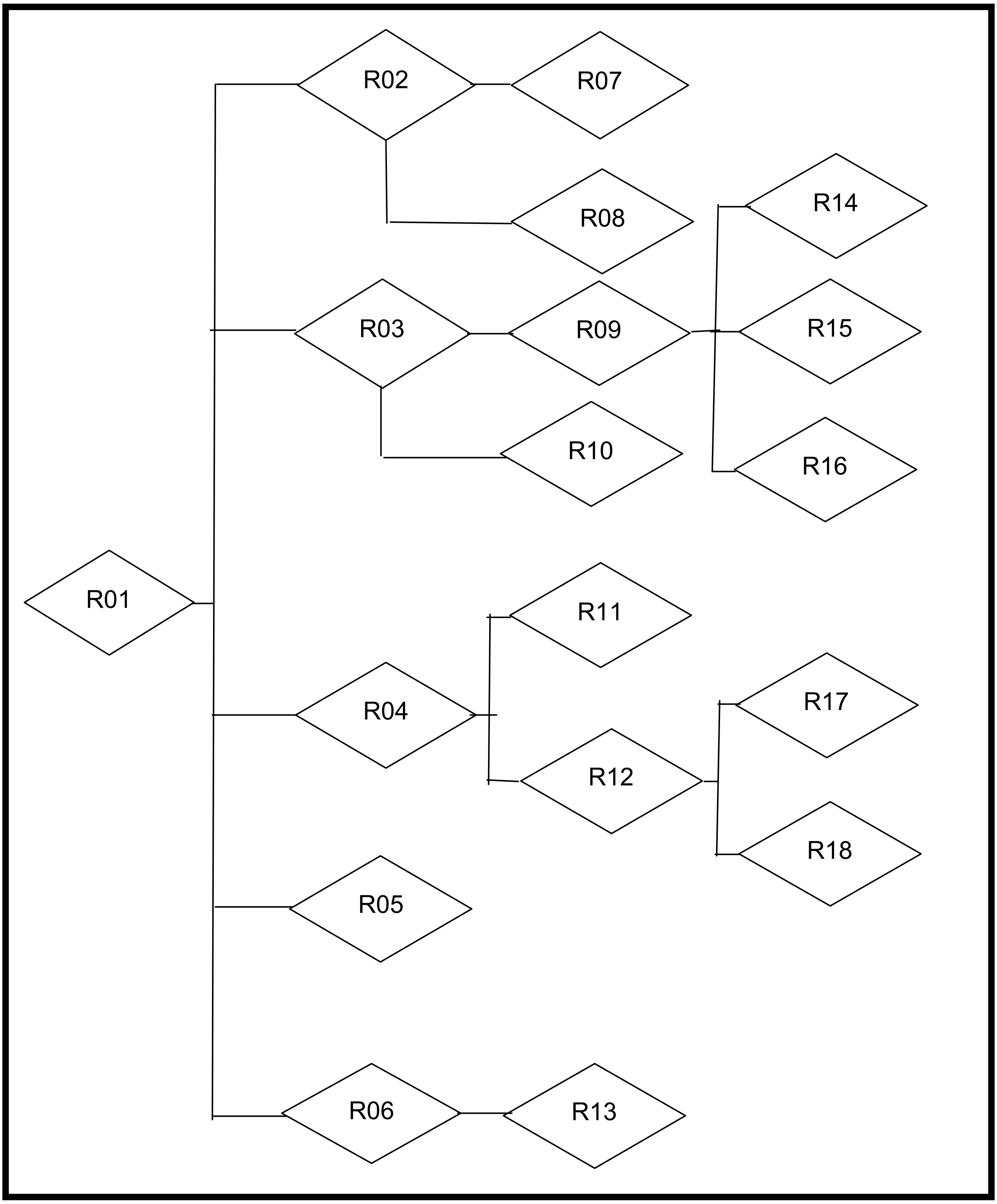


Figure 6.6: The Result Structure Chart of the Proposed Patient-oriented Flow (OS)

The result numbering is not trivial, but it rather signifies a certain unique hierarchy of results. The first hierarchical line of the above figure of exploded results (R02-R06) is directly relevant to the model's core transactions included in the proposed processes that follow. These transactions form the performance cells of each process. Once these core transactions' results are produced in the proposed processes structure of the flow, then the patient-oriented concept is feasible. The second hierarchical line of results (R07-R13) is relevant to supporting secondary transactions that need to be in order before the production of the first line of results. That means that certain acts of these secondary transactions should be in accordance with the process model's rules produced next, before the patient-oriented performance of the system is measured. Finally, the last line of results (R14-R18) is also included in the previous result hierarchy and follows the same logic of the secondary transactions.

6.3.5 The Construction and Organisation Synthesis

The construction synthesis will produce a model of a healthcare organisation that specifies its composition, its environment and its structure. A minor but necessary step in this process is the definition of the actor's relationships concerning their interaction with the internal and external environment of this model. A decision that has to be taken is what part of the patient flow ontological model's construction will be managed by the internal environment (HCO) and which part will be managed by the external environment which is the NHS. The primary healthcare transactions according to the literature review (see Figure 2.13) are directly affected by the external (remote and operating region) and internal environment (infrastructure region).

The dotted boundary, exhibited in the detailed ATD next, is the external environment, that is, the Greek NHS and it is called the operating region. The remote region, which is the European Union environment, is another region of the external environment, and, although it is partly outside the scope of this study, it is taken into consideration to the point that the Greek NHS has become compatible with the EU healthcare directives. According to the literature review, the accessibility parameter makes this industry unique. Every individual should have the right to equal healthcare services. This model is compatible with that parameter, as the patient could initiate action to enter the system. The flow of every patient, on the other hand, is relevant to the legal structure and national policies concerning the NHS environment and is beyond the scope of this study. The infrastructure region, in an effort to capture both the private and public healthcare system, separates the healthcare organisational boundaries into primary, secondary and tertiary levels. For the purpose of this model's methodology, the kernel will be considered the secondary level. The EPR spine interoperability through EDI and its implementation of the supporting information system of this model is, however, necessary for the purpose of this study. The transactions analysed in this internal environment are presented as diamonds inside the circles. The circles signify the "c world" which means that system's actors are coordinating in order to produce results that are signified with the "p world's" diamond that is inside the circle. This means that the subjects "performing" acts should have the responsibility for coordinating their acts and also the competence for their production.

Actors are noted inside a square box which signifies that they have the authority on this model to act according to their roles. The actors, who all belong to the subject world, have two types of roles: elementary and composite. The elementary roles contain no specific interaction with other actors relevant to the result produced. They are signified by a blank square. The composite role actors are signified by a grey square, and they actively interact though intersubjective Habermas communication signs exhibited above with other system's actors.

The subject actor patient is characterised as a composite actor with an ontological code Composite Actor 1 (CA01). Based on the enterprise ontology domain dichotomy, this means that the subject patient could comprehend, based on explicit knowledge provided by a set of measures which evaluate the transactions of the healthcare system, its medical condition abbreviated referred to in this study as the object "patient condition". Thus the composite actor "patient" could decide according to the POMRS and choose alternate flow paths or exit the system. Actually, according to their individual limitations, all other subject composite actors bear full responsibility for the ontological transaction that they produce in each process of this ontological structure. These composite actor roles perform transactions included in the CRISP model, that is:

- ✦ C: a set of C-facta, called coordination. For C the actor has an agenda of actions (example: treatment actions) that have to be satisfied for a transaction to be completed.
- ✦ R: a set of action rules, called rule based. This rule defines that the product of C actions and the set of S (‘patient condition’) declare the domain of R.
- ✦ I: a set of intentions, called intension base. For I there is a set of intensions necessary for the c-facta (‘patient condition’ results of the responsibility world, C-world) that are taking place within this model.
- ✦ S: a set of facta and stata, called the state base. The state base contains all instances (‘patient condition’) that have to be known in order for an actor to have the responsibility (P-world) to perform.
- ✦ P: a set of P facta, called the production base. Is the sum off all transaction results that the actor (example: doctor) produced due to the responsibility that has.

Finally, the following figure includes two more types of lines and a boundary. The line with an arrow at the end signifies that the actor is the executor of the transaction. On the contrary, a straight line with no arrow indicates an actor that is the initiator of an action. The frames around the actors signify the organisations’ physical boundaries like GP office or hospital. The diamonds inside the circles signify the transactions performed. The hierarchical numbering of the transactions signifies that the first six transactions are core transactions and encompass the second and third line of transactions from number eight to eighteen (see Figure 6.6).

The private sector, however, allows further flexibility concerning patient choice, and the ATD model is more accurate in its interactions. On the other hand, according to the literature review, most patients in Greece use their public healthcare coverage, fully or partly, during their flow through the healthcare system. The DEMO Global Actor Transaction Diagram is necessary at this methodology step (see Figure 4.6) for modelling business systems. It models the relevant business systems in the domain that is being modelled and the interactions between these systems. These systems, as mentioned above, are called 'composite actor roles' or 'composite actors'. The target system itself is also modelled as a composite actor. The composite actors interact with each other by performing transactions. In all the transactions exhibited below, one composite actor (the initiator) requests another composite actor (the executor) to perform a certain healthcare action, e.g., to make an appointment, to analyse a document, to make a diagnosis etc. Another concept is a production bank in which information is stored that the model actors use. The supporting information system at info-logical and data-logical levels serves as a production bank that, implemented with the usage of the CLIPS technology, will store all relevant models and information, thus completing the framework of this study’s concept design. The following Actor Transaction Diagram (ATD) exhibits the complete detailed ATD structure of the proposed patient-oriented healthcare flow:

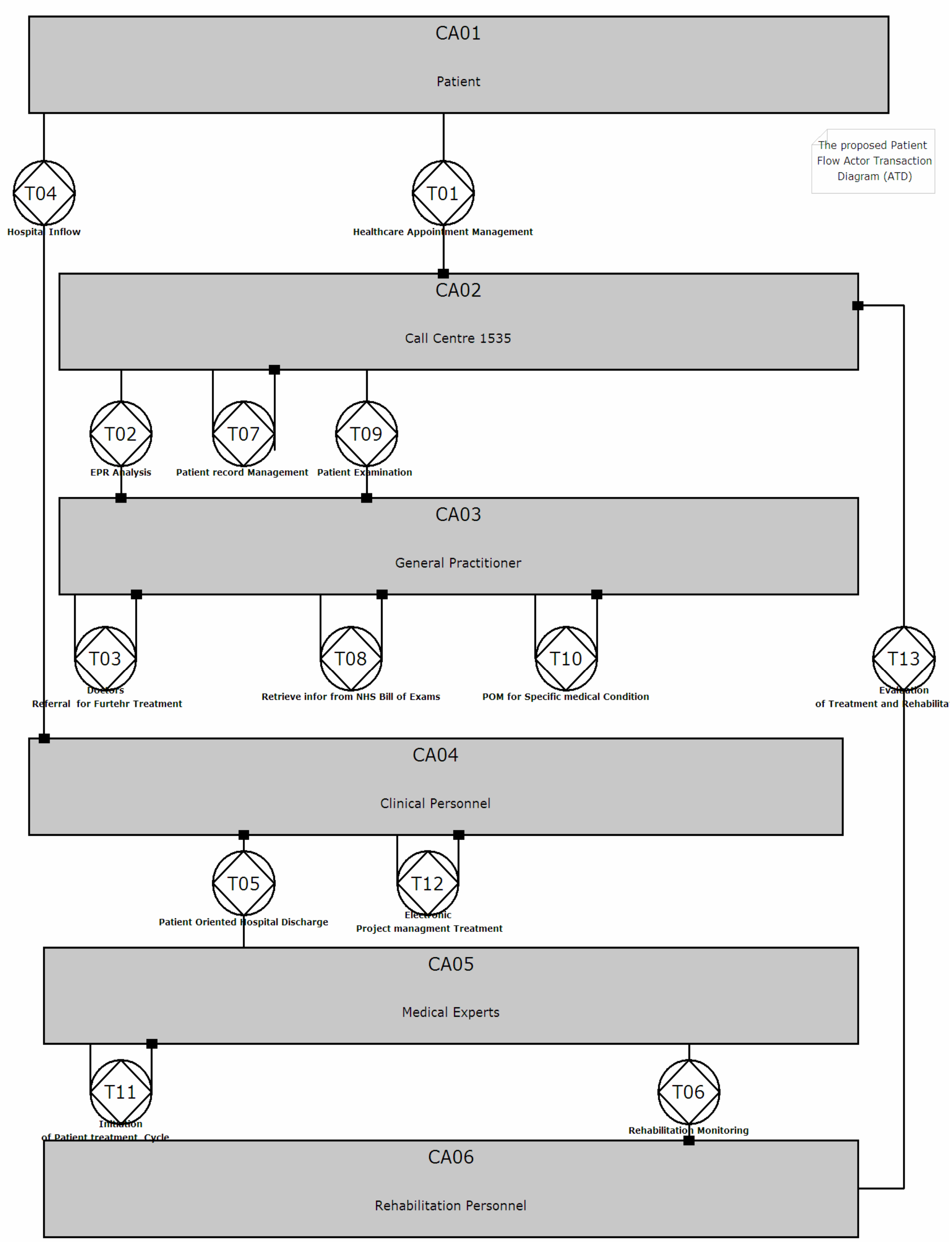


Figure 6.7: The Complete Detailed ATD of the Proposed Patient-oriented Flow (OS)

The above figure strictly analyses the production acts occurring within the healthcare flow. As it includes all the system's actors that play a composite role in this proposed structure, the reader could further comprehend the span of responsibility at every step of the flow. It is obvious that core production acts T03 and T04 are the full responsibility of the actors "GP" and "clinical personnel" respectively. They are both initiating and completing the production of each production act. Other core production acts like T01, T05, and T06 have different initiators and deliverers. Specifically, the flow of the T05 act has an opposite direction from the patient flow. The reason is that the initiator "medical expert" and the actor that delivers the production act to "clinical personnel" both interact with an organisational internal process. These processes do not slow down the flow of the patient, as explained in the literature review, whoever wishes to find treatment passing all necessary organisations of the national healthcare system safely and fast.

All the other transactions included in the above figure are secondary and tertiary transactions, which are also relevant to this flow restructuring. They play an assistant role to the six primary transactions, as they also indicate the span of responsibility of each of the actors. The reader of the above figure should simultaneously pay attention to the previous figure 10.5 and Table 10.6, which are designed for understanding the hierarchical production level as well as the transaction type and result. All of the other acts that are previous (request and promise acts) or subsequent (state and acceptance) to these production acts assist in completing the full communication agenda of issues that have to be tackled by the indicated actors. The process models that follow will further analyse the flow of every act necessary for the production of the results exhibited to the previous figures.

The ontological infrastructure produced entails all the necessary processes, transactions, acts, facts and measures necessary for a patient-oriented flow. Once the novel process flow is produced and each data instance is stored in the CLIPS program, then all the system's actors will have to follow processes produced, which will be evaluated based on the patient-oriented measures analysed according to the BB model of the DEMO methodology.

6.3.6 Introduction of the Novel Restructure and the Performance Measures of the Patient Flow Process Model

The next step will analyse all of the above proposed, core patient flow transactions to specific process steps delivered through the construction and organisational synthesis. The process model will specify each one of the six core transactions and will include all the secondary transactions as hierarchically numbered in the previous section of this chapter into four processes, which, based on the WB model principles as presented to the previous chapters, could improve the patient orientation of this flow.

All of the processes depend on the initial core process which is for the patient, to enter the healthcare flow by making an appointment (see Figure 10.6). According to the Habermas LAP model which was briefly explained earlier, there are three spheres of human existence that play roles in this communication: the objective, the subjective and the social or intersubjective world.

The objective world of all these transactions presented and encompassed inside the proposed processes contains all possible conditions relevant to the medical condition of the patient and conforms to all the types of patients that wish to make an appointment in order to proceed within the patient flow. The population of these patients could belong either to the private or the public sector. The patient requesting an appointment in this call centre, that serves all elective patient conditions, could demand certain processes:

- To make a doctor's appointment
- To receive a doctor's diagnosis or referral
- To make a doctor's appointment for operation or medical examination's appointment or any combination of the previous processes.
- To exit the system in a patient-oriented way

The subjective world is unique for every subject and concerns all the novel processes of this patient flow restructure. In this case, the patient who as a speaker is performing a communicative act raises the claims for truth, justice and sincerity. The claim for truth is relevant to the objective world and the patient condition. The patient's request for an appointment is assumed to be sincere, as it is based on a true patient condition. Thus, the claim for sincerity is relevant to the subjective world as the patient (speaker), who communicates with the secretary/call centre (hearer), is sincere when the request is expressed. The claim to justice, which refers to the social world, assumes that the transaction for making an appointment is based on rules that are just. The diagram below analyses this transaction pattern. The transaction has three phases that will be followed in all the restructured processes:

1. The order phase (O-Phase) which is the first transaction phase. In this phase, for example, the initiator, according to the ADT could be the patient entity (CA01) that enters the system and triggers the transaction. The executor (CA02) who is the actor named “general practitioner’s secretary/ call centre”, is the one that delivers the transaction. The CA01 entity and CA02 entity, in order to reach an agreement for the transaction, have to cooperate with a specific manner socially acceptable for all the processes in this model of enterprise ontology that is called intersocial. If the result is agreed, between the two actors, then a production fact is in existence. In the following diagram the elliptical scheme represents a C-act type. A C-act type is a promise of a transaction that has specific time and result (C-fact) and is initiated by an actor that has the authority to do so. In this example, the initiator is the patient and the executor is the secretary.

2. The Execution Phase (E-phase). This phase refers to the production act and fact. Another elliptical scheme is a P-act type and states that a promise has been made by an actor that has the authority (patient). The diamond is a P-fact type that signifies that a promise has the specific result required by the patient and is implemented by an actor that has the competence to do so.

3. The result phase (R-phase). This phase refers to the result of the transaction, and the result is relevant to the type of transaction that takes place. The result has to be stated and accepted by the recipient actor who in this study is primarily the actor “patient”.

Concluding, all the above transaction acts of requesting, promising, state and execution are being noted with an elliptical shape representing the Habermas LAP ontological principles. Finally, the objective world includes all the type's of patient conditions, insured through the public or both the public and private sector, requesting healthcare services through the following transactions and processes. All the transactions and processes have a specific result. All the transaction results are exhibited in the TRT Table of this chapter.

All the promises that actors make through the indicated primary and secondary and tertiary transactions must be in accordance with the specific results of the TRT Table. Then and only then do the acts of the subjects become facts. This means that the facts should coincide with the specific patient-oriented results indicated in the TRT Figure 6.6. These results will be measured with the support of the information system introduced and info-logical level. A threshold of each measure will translate the acts performed into facts and thus to patient service type A or B.

Finally, this redesigning methodology will produce the OS, which is the patient-oriented framework including the model, the supporting information system's measures presented the next chapter, and the action rules included in appendix 1 as well as in the attached software. Thus, the following redesigned primary processes will be produced:

- ✦ P01: From patient appointment to GP (contemporary process) to Patient-oriented inflow process (proposed process)
- ✦ P02: From the patient referral process (contemporary process) to patient treatment referral process (proposed process)
- ✦ P03: From the contemporary treatment process(contemporary process) to reconstructed treatment process (proposed process)
- ✦ P04: From the discharge process (contemporary process) to patient-oriented outflow process (proposed process).

6.3.6.1 Proposed Situation in Greece. Process 01: Patient-oriented Inflow

This novel process holds a non conditional relationship with all of the rest processes presented in this chapter's section. In the models exhibited, the processes' grey actor areas denote on the models exhibited the span of responsibility of each actor. In this way, the agenda as well as the service produced at every transaction step are included within the area of responsibility of each actor. This means that according to the following actors' acts it is obvious that this call centre serves as a single point of interface between the patient and the healthcare system. If there are any deviations of the rules set and explained in this section for every process, then the actor "call centre" has to be informed by the patient (see Appendix 1: Action Rules). The NHS could provide a simple handbook of the patient's rights, and thus the patient could understand this unconditional patient-oriented relationship set. At every transaction step, the patient will be informed through the supporting information system that will be provided at each healthcare level from this single point. These reports will relate to the results, for the purpose of this process, as presented in the previous chapter (see Figure 6.3. The first novel core process P01 includes the following transactions:

<u>T01: Healthcare Appointment Management.</u>

This transaction results in the initiation of the patient relation management, according to the TRT of the elective patient flow (Figure 6.6). It is different from the existing one, as it results in introducing to the patient a unique communication point that could arrange all the patient's healthcare flow needs. Patient relation, according to literature review of this study, is a critical success factor, according to the POMR2 patient value-added satisfaction formula presented (Table 6.4). This transaction is heavily redesigned from the currently-existing one, as the patient-oriented concept is applied. Based on this concept of a patient-oriented flow the call centre should be the single point for managing and administering the patient flow, through all levels of healthcare (Figure 6.2). This is the reason this actor's status changes to composite actor status (CA01) Although this actor does not belong to the system's kernel, this is the most important managing transaction, as it is directly linked with the diagnosis transaction, since, for a patient-oriented model, this is the first and should be the last recipient of the POMR4 report. These call centres are administered directly by the ministry of healthcare and not by the hospital administration. These public healthcare call centres are established physically in general hospitals throughout Greece underscoring the importance of the system's kernel of this study (see Figure 6.7).

T01RQ: Healthcare Appointment Management.

This act is performed by the actor "patient". In this act the patient requests for any type of appointment with a healthcare resource that includes both tangible and human resources. The recipient of this act is the call centre or alternatively the GP. The status of the call centre changes from its current situation status of simple actor to composite actor (see Figure 6.7). The reason is that in this novel approach the "call centre" actor manages the patients' relations for possible flow paths into the healthcare system. Finally, upon the patient's request the patient has to declare the name, public insurance data and the medical history.

T07: Patient Record Management .

This secondary transaction is necessary in order to provide the full control of patient record that is the result required by primary transaction T02. The results required by this transaction are the storage, indexing and retrieval of EPR (Figure 6.7). They are considered secondary results, which support the primary ones at T02. The record management is the responsibility of the call centre for all levels of healthcare, according to this proposed process. Thus, the result of the T07 transaction is the storage, indexing and retrieval of the patient records. At this point the researcher should note once again that this ontological flow follows the action rules produced and not the conditional exceptions (see Appendix 1: Action Rules). The call centre is responsible for managing complete quality data stored in the CLIPS. On the other hand, the result of the next transaction, that is, the retrieval of the patient condition information from this ontological data spine (T08) should be a doctor's responsibility. The updating of these acts requires tacit medical knowledge and should occur electronically possibly with the assistance of administrating personnel, once the doctor's knowledge is delivered. Both of these transactions are necessary future transactions that have to be implemented in the Greek healthcare environment.

T02RQ: EPR Analysis.

This occurs at the "call centre" actor when the patient requires an appointment with a GP through the call centre line. The call centre should be allowed to check the date of the last update that the patient historical record states. The self activation sign, a thick line that initiates and terminates at the same "call centre" actor, signifies that this actor requests a routine operation without any specific request. This actor should have access only to the administrative information. Specific examinations are required for every patient condition from this actor and should be included in the bill of examinations of the previous transactions and serve as a field for guiding the patient until the GP examination (see Figure 6.8). If the historical record pattern of public healthcare visits, based on electronic healthcare record of the patient, is not cohesive with a potential NHS framework's pattern, then the call centre stops the patient's appointment process. For example, this national bill object type of specified exams or visits serves as a campus much like the practice of evidence based medicine process presented in literature review. It forbids healthcare abuse by repetitive unnecessary patient's examinations. On the contrary, if the patient is entitled to a visit, the call centre assists by requesting an appointment according to the patient needs. At T15 Laboratory tests and T16: Clinical Tests these transactions are relevant to examination activities but they vary in their management approach.

T01Execution: Healthcare Appointment Management.

This act is performed by the actor CA01 "call centre" or alternatively in the private sector by the same system's actor CA01 "GP secretary". If the entire patient documents are audited from the call centre, a promise is made for a future appointment at a date where its priority is directly linked to the patient's condition. If the patient lacks necessary data the call centre does not arrange for any action until the patient data object type is complete. Only then does this act become a fact. Then this conditional execution, according to the process actions rules, is filtered trough the necessary transaction acts that follow and assure that the necessary healthcare appointment requested fulfils all the medical prerequisites for an effective flow. This means that, based on the patient's condition request, the call centre should check if there are prior medical exams that have to be fulfilled before satisfying the patient's request. This administrative process demands that the call centre should have the policy where a bill of necessary examinations object type is documented before any diagnosis object type. According to the specific patient condition, there is currently in existence such a document that requires specific proposed exams that have to be completed per “patient condition” before the GP makes a diagnosis act. Such a policy should be followed based on public insurance (IKA) manuals, which refer to necessary examinations required for each patient’s condition request. Once this manual is produced in electronic on-line form, there will be limited doubts regarding the “patient’s condition”. So the status of communication between the call centre and the GP office will be informational and not essential. Thus, the doctor should always be contacted for data excellence before the appointment. The T01ST and T01ACC are exhibited at the end of this analysis, as, according to this novel model, there is a potential alternative route of further laboratory or clinical examinations transactions that may be followed (see Figure 6.8).

<u>T15RQ: Laboratory tests and T16RQ: Clinical tests.</u>

These two transactions could be managed differently at this stage. Clinical tests could be assigned to the public sector at the same hospital where the doctor’s appointment will take place, as they are available to almost every public hospital. In this way the patient could visit a single hospital’s clinic and implement both the exams and the doctor’s visit. Furthermore, if the call centre schedule allows, both visits could take place the same day. The possibility for a same day appointment for both clinical tests and doctor’s appointment is possible, as, currently, doctor’s visiting hours are during the evening and clinical tests are scheduled during the day. A laboratory test, on the other hand, may not be available at every public hospital as clinical tests are due to lack of necessary infrastructure. In addition to the request act, all the other acts of these secondary transactions at the third hierarchical structure level (see Figure 6.6) could be handled according to each hospital’s infrastructure through the call centre. The exact management of this secondary transaction is outside the focus of this study, as this redesign primarily occurs at core transactions and processes. Once all primary transactions and processes are redesigned, measured and evaluated then this ontological framework could be further reengineered at secondary level. An acceptable result for both of these transactions should include the safety factor measure (see Table 6.3) .Proper time management as both transactions are required as early as possible in this flow assure, in addition to safety examination, effectiveness.

T02PM: EPR Analysis.

The GP checks the patient's EPR medical historical record. The GP enters the patient's record through an access code received from the NHS. If the record is complete, the GP accepts the EPR status and promises an appointment through the call centre. If the GP needs to update the medical patient condition with new examinations, then a request for these specific examinations is placed on this patient's record through the central EPR spine from the GP. This means that this is a conditional act for a complete patient record required before the patient proceeds to the GP's appointment.

The transaction of T02 is noted in the following figure through an arrow that initiates and ends at the same transaction step for two actors. This type of transaction is for both actors a self-activated activity at request stage and at promise stage. The self-activated notation ensures efficiency in administration for actor "call centre" and effectiveness for actor "GP", as administrative audits ensure qualitative patient flow. Then, once all the necessary exams or other tests are completed, the GP accepts the patient appointment. The doctor's tacit knowledge is necessary for the T02 execution. An ontological examination flow model relevant to each type of disease that relates to all necessary exams before a GP appointment could be a solution for the doctor's execution of the EPR analysis. In this way, it is possible for the call centre to check the exams and confidently to make an efficient appointment with the doctor. On the other hand, this act enables the actor "GP" to have the big picture for the scheduled patient appointments for optimum time management.

T02: EPR Analysis.

In this transaction, two composite actors are involved. The call centre, since it is the initial unique point for patient communication, and the GP. It is important at this point to describe the info-logical activity occurring between these two actors. This communication is relevant to patient data. According to this model's supporting system POMRS, this ontological act is of major importance, since according to the European directive ISO/TC 13606-4 as of 2007 privacy of this communication act should be guaranteed.

T15RQ: Laboratory tests and T16RQ: Clinical tests.

These two transactions could be managed differently at this stage. Clinical tests could be assigned for the public sector at the same hospital where the doctor's appointment will take place. Such an infrastructure is currently available in almost every public hospital. Further management of this secondary transaction is outside the redesign of this study.

T08: Information Retrieval from NHS Bill of Examination Database.

This secondary transaction is necessary in order to provide the full control of the patient examination record that is the result required by primary transaction T02. The results required by this transaction are the interpretation of the information based on expertise (see Figure 6.6). The secretary should have a complete database of the necessary examinations that are in order before the diagnosis of any "patient condition". A simple verification required from the GP could take a minute if not automated in a later development stage of this model. Nonetheless, the actor "secretary/call centre" should provide the statement or result of the examination to the actor "GP" and receive acceptance before of the patient appointment is arranged. This secondary result, which supports the primary T02 record management, is the responsibility of the call centre for all levels of healthcare according to this proposed process. So, the result of the T08 is to be measured for actor "call centre" once the GP provides the check and acceptance of the examinations accordingly. At this point, the researcher should note that this ontological flow follows the rules produced and not the conditional exceptions (see Appendix 1: Action Rules). The actor "GP" is responsible for checking and accepting the examination results, and thus is partly involved in the performance evaluation of this transaction. Further analysis, once again regarding the structure and results of secondary processes, is directly relevant to the implementation and evaluation of the primary ones (see Appendix 1: Action Rules). The qualitative updating of this tacit medical knowledge could occur electronically with the assistance of the POMRS database stored in the CLIPS. This transaction as well as T07 is necessary future transactions that have to be implemented in the Greek healthcare environment.

T02ST: EPR Analysis.

Then in the next activity, once the doctor considers the patient record complete, the call centre arranges an appointment for the patient. In case of an incomplete patient record a doctor's examination electronic referral form attached with the EPR is in order so that the patient proceeds for further examinations. In this way the patient is informed by the call centre to perform the requested exams and then to set a doctor's appointment. Again, this referral is prerequisite for this step as the secretary has no tacit knowledge to assign other examinations than the ones initiated by the available document of the bill of examinations. Based on the above activities of the EPR analysis transaction, the entire currently unnecessary patient's appointment to public doctors in order to receive an examination referral object type will be avoided. This appointments' bottleneck will be abolished not only due to elimination of unnecessary appointments but also due to proper management of the patient condition.

T02ACC: EPR Analysis.

The call centre now has to accept the doctor's proposed appointment dates, which in practice should actually denote a lead time for the patient examination. A serious patient condition will be handled immediately from the call centre by setting an immediate appointment versus a not so serious patient condition which will receive a logical lead time for a GP appointment.

The actor "call centre" actually based on this step could fully coordinate an efficient examination appointment schedule. This actor is the completer of T01 and is also the receiver of information from the T02 execution from the GP. In this way, the T01 appointment setting could be implemented effectively, as it recognises the patient condition's proper flow.

T01 ST: Healthcare Appointment Management.

This act is performed by the actor “call centre”. Once the call centre arranged the necessary appointment, with or without the GP’s assistance, according to the healthcare manual, then T01 triggers an explosion of primary processes as well as secondary processes. The result of this transaction includes the patient appointment with a GP but also, for a measurable patient-oriented flow, could include any other services which are legitimately required by the patient. This is the reason why the result of this transaction is tagged as initiation of patient relationship management. According to this transaction, the patient initiates a communication at this call centre that manages the healthcare needs according to the NHS. In this way, the call centre point could manage efficiently and effectively manage the patients and link them properly with all the necessary healthcare resources.

T01 ACC: Healthcare Appointment Management.

This act is performed by the actor “patient”. The execution of the appointment is set based on the patient needs at a time that is acceptable to the actor “patient” based on the above healthcare policy and transaction step. The next transaction encompassed in this process is the EPR analysis, which is necessary for the doctor’s diagnosis. The patient’s historical record object type should be complete at the examination time, either with or without the GP’s assistance. In the referral process that follows, the EPR should be complete before making any diagnosis.

These types of results of both T08 and T02 are subject to POMR functional information system. The analysis of this transaction’s activity is important as it refers to the disclosure issue encompassed in the POMR2. The next Information Use Table (ITU) specifies further for the object class of all elective patient conditions, fact types and result types from the state model of this process. This means that for every elective patient condition object class the following Table specifies at which step of the process the instances (patient conditions) must produce a fact type and a result type.

For example, the appointment date setting transaction is a fact at the step T01RQ when the patient requests a specific appointment date from the call centre. The complete EPR should be a fact at step T02 RQ when the call centre initiates this control. If the EPR not complete, then the call centre proceeds with requesting referral from the GP for further exams indicated by the bill of examinations available at the T02RQ step or the GP assigns more exams based on the tacit knowledge at step T02 PM. The necessary information required for the completion of every process is represented in an Information Use Table according to the DEMO methodology at this step 6 of the adopted methodology (Figure 4.6) as it explains what kind of information is going to be used for the next figure transaction P01 (Figure 6.8).

object class, fact type, result type	**process steps**
Patient Condition (P)	T02RQ, T02 ST
Appointment date	T01RQ
Insurance Status Documents	T01RQ
Complete EPR	T02RQ
Bill of examinations	T02RQ
Examination Referral	T02 PM
Clinical& Laboratory results	T15&16 Execution
Storage, indexing, retrieval of patient records	T07 Execution
Retrieve information from NHS bill of examinations	T08 Execution

Table 6.8: IUT of the Proposed Process 01

Based on the redesign step 6 of the adopted methodology the following figure demonstrates the process model of the OS:

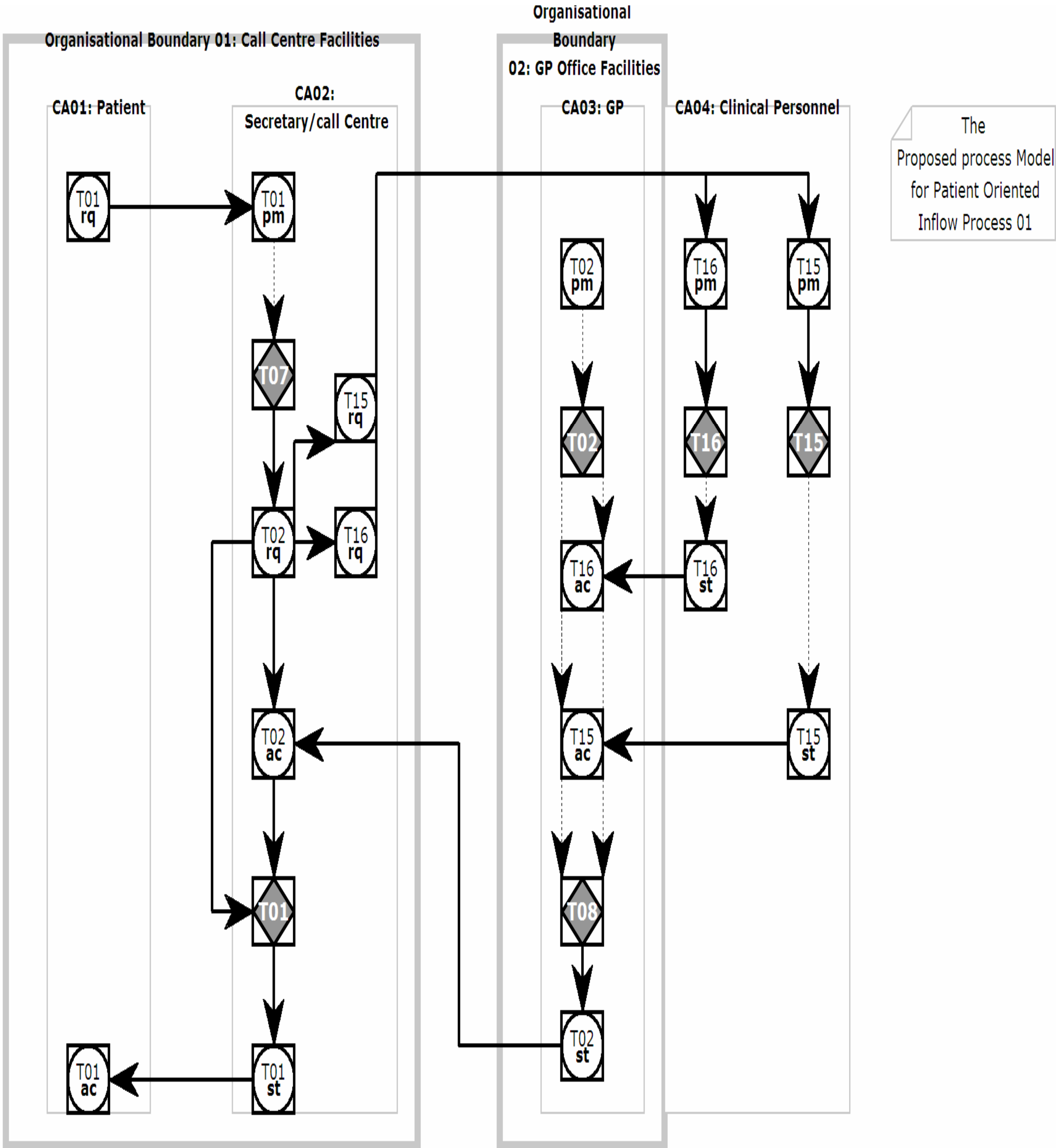


Figure 6.8: The OS Process 01 Model of the Proposed Situation

According to the above figure, process 01 terminates at the execution of the T01 transaction, which is the reservation of the GP appointment's at a mutually agreed time with all the necessary medical data relevant to the patient's condition (see Appendix 1: Action Rules). Based on the above figure, the next section presents all the necessary measures for the process evaluation relevant to the process.

6.3.6.1.1 Proposed Process 01: Supporting Information System Relevant Measures

The measure proposed for this process is the appointment measure number one from the access set of measures POMR1 Exploded Report (see Table 6.3). The following is the formula for this measure:

✦ **Appointment measure (t) = S (t) Process one + (t) T09RQ +T09PM = Sum (t) (T01RQ, T09PM)**

where t equals time in days and S(t) of process one, T09RQ and T09PM equals the time necessary for the patient to visit the GP

Relevant Ontological Processes Figures:

✦ Figure 6.8: The OS Process 01 Model of the Proposed Situation

✦ Figure 6.9: The OS Process 02 Model of the Proposed Situation

The (t) time frame depends on the "patient condition" instance that enters the flow (see Figure 10.2: The Patient-oriented Ontology Parallelogram linked to Measurements).

According to the access measurement set presented earlier and specifically measure one of the POMR1 exploded report, the appointment measure is the supporting information system's relevant measure used for this patient-oriented process. This measure equals the time passed from the initial GP appointment request that is expressed by the actor "patient" according to the process one figure at T01RQ transaction phase (Figure 6.8) until the actual appointment performance T09 implemented at process model 02 (see Figure 6.9). From transaction act T01RQ until transaction act T01ACC there are many transaction acts that have to be completed before the appointment is arranged. In this way, the time estimated for the GP appointment, measures a patient-oriented structure, so that the time frame that will be evaluated through this appointment measure complies with the concept of this ontological model. It is useless for a patient to perform the appointment act with a great score in this measure and not fulfil all the proposed acts produced. Such an act of visiting a GP with lack of necessary examinations currently prolongs the lead time necessary for the GP appointment. Thus, this measure outcome, based on the ontological flow of this study, is a leading indicator towards an efficient and effective service for a patient-oriented flow.

6.3.6.2.1 Proposed Process 02: Patient Treatment Referral

This proposed process follows the patient-oriented inflow process. As the call centre with the GP's assistance prepared the appointment, the patient has a good chance to proceed efficiently for further treatment. Any other referrals that are not relevant to extraordinary ad hoc patient conditions are considered evidence towards mismanagement or ineffective process 01 according to the measures that follow next (see Figure 6.9).

The secretary/call centre continues to be considered a composite actor in this proposed process and based on the above process steps executes the appointment arrangement T01.

<u>T09RQ: Patient Examination.</u>

The patient request of the indicated appointment has to be satisfied by the actor GP once all the previous acts of the P01 process transactions are fulfilled. If the patient, for any reason, does not have all the necessary acts fulfilled, the appointment ends without the examination at this point. Otherwise

T09PM:Patient Examination is triggered. This promise is effective immediately as all the necessary acts up to this transaction are set. The patient examination occurs and the GP performs this act with all the necessary and updated data on hand.

T09ST: Patient Examination.

The GP states the situation results formally to the patient according to the usual current situation communication act. Alternatively the GP, based on the examination, might need extra laboratory or clinical examinations that have to be conducted before performing this act of examination statement which results in diagnosis. In this situation, as the following figure denotes, there is priority management in effect for this patient. This means that due to the patient's ad hoc extraordinary medical condition, the GP has to receive the patient immediately after this transaction loop of the next patient flow process figure. This process loop ends before the GP proceeds to the next transaction T11 (see figure 6.9).

In the case that the GP could not diagnose any medical condition or the patient's condition is outside of the GP's tacit knowledge, then, again at this point, a referral to the proper medical expert is in order. Due to the extraordinary patient's condition, this alternative path process ends at the point where the patient visits the medical expert. As the patient's future condition is considered extraordinary, the treatment of the patient will be managed per instance.

T10 Execution and T10ST: Patient-oriented measurements analysis for patient condition.

At this point, the GP, based on the proposed situation without the patient's request or any future promise, proceeds to the execution of the patient-oriented measurements analysis for the specific patient condition. The result of this communication is the value-added treatment proposal of the GP. The value-added of this proposal is now in the comprehension of the alternative patient flow paths that the actor "GP" communicates to the actor "patient".

T10ACC: Patient-oriented measurements analysis for patient condition.

As the actor GP has all the explicit knowledge necessary from the patient's updated healthcare records, due to the previous process, a diagnosis based on hi/her tacit knowledge is as efficient as possible. This means that the patient has to proceed to the next step of accepting the GP's diagnosis. Alternatively, there is always the chance, for any trivial reason, that the patient does not trust the GP's diagnosis or there is fear to proceed to treatment transactions. Thus, this patient could exit the system and decide what to do next.

T01RQ: Healthcare Appointment Management

For this act the actor "Patient" that has rejected further healthcare flow through the initiated path has to state this act to the call centre and secretary. This means that, in the updated patient record, the GP's proposal should be enough for the patient to explain and the "call centre" actor to clearly state the reason for this action, as it is stored in CLIPS supporting information system (POMRS) and registered on record. It is a valuable piece of information for further healthcare management. As the patient could exit the NHS or change the healthcare flow path. Thus, the patient experience questionnaire POMR4 is also required. The actor "call centre" will finish this transaction by accepting the report. Thus, the record management, as in the previous process, is the responsibility of the call centre for all levels of healthcare. Further analysis in this process's transaction regarding the structure and results of secondary processes is outside the focus of this study, as it is directly relevant to the implementation and evaluation of the primary transactions.

T09ACC: Patient Examination

The ACTOR "patient", as it eliminated prior alternative flow paths, has to accept the GP's diagnosis and trust the GP's tacit knowledge and proceed to the next transaction of this process. On the other hand, the GP, according to this secondary processes result, should be able to at least deliver a decent diagnosis for the patient. In this way this secondary process result does not create an operational bottleneck in the patient flow, creating problems at primary processes level.

T03RQ: and T03: Execution of Doctor’s Referral for Further Treatment.

This transaction is initiated by the patient, who is informed of all the previous transactions about this flow process and, thus, requests a referral. This referral is executed without any delay or promises from the GP, and it is relevant to the patient’s treatment. Once again, the result of T03 based on the previous processes should advance the patient to the next healthcare level.

T03ST: Doctor’s Referral for Further Treatment.

This transaction step is initiated by the GP, who states the referral officially. At this point the patient will also receive from the GP a written report POMR2 (see Table: 6.4) with the patient value-added service. This report will include, as mentioned in the previous chapter, the results of the hospital’s patient-oriented measures results all in a sum of one number that is included in the POMR2 report. In this way, the actor “patient“ immediately has a big picture relative to the patient condition, and the hospital’s entered operational healthcare status fulfils the EEC directives for patient privacy. Alternately, mostly to save doctors’ precious time, the patient could receive this report from trained clinical personnel and analyse it immediately before proceeding to the T18 transaction of electronically recorded treatment performance. This act, once it becomes a fact by the patient receiving analysis of this report either at transaction T03 or T04, and only once completed can the aware patient proceed with the flow processes.

T03ACC: Doctor’s Referral for Further Treatment

This transaction ends by the patient’s acceptance of the results of this transaction as well as all the previous acts turned into conditional facts based on the following measures results. All the above transactions and actions complete this process 02, which is the patient treatment referral.

The necessary information required for the completion of patient treatment referral process 02 is represented in the following Information Use Table (IUT). All this information is included in the above transaction phases produced.

object class, fact type, result type	**process steps**
Patient Condition (P)	T09,T15,T16,T14
Diagnosed Patient Condition (DP)	T09ST
Appointment date	T09PM, T09
POMR2	T03ST
POMR3	T10ST,T10ACC
Treatment Referral	T03ST
Clinical & Laboratory results	T15&16 Execution

Table 6.9: IUT of the Proposed Process 02

The following figure analyses the transaction phases of this process that once again is initiated by the patient:

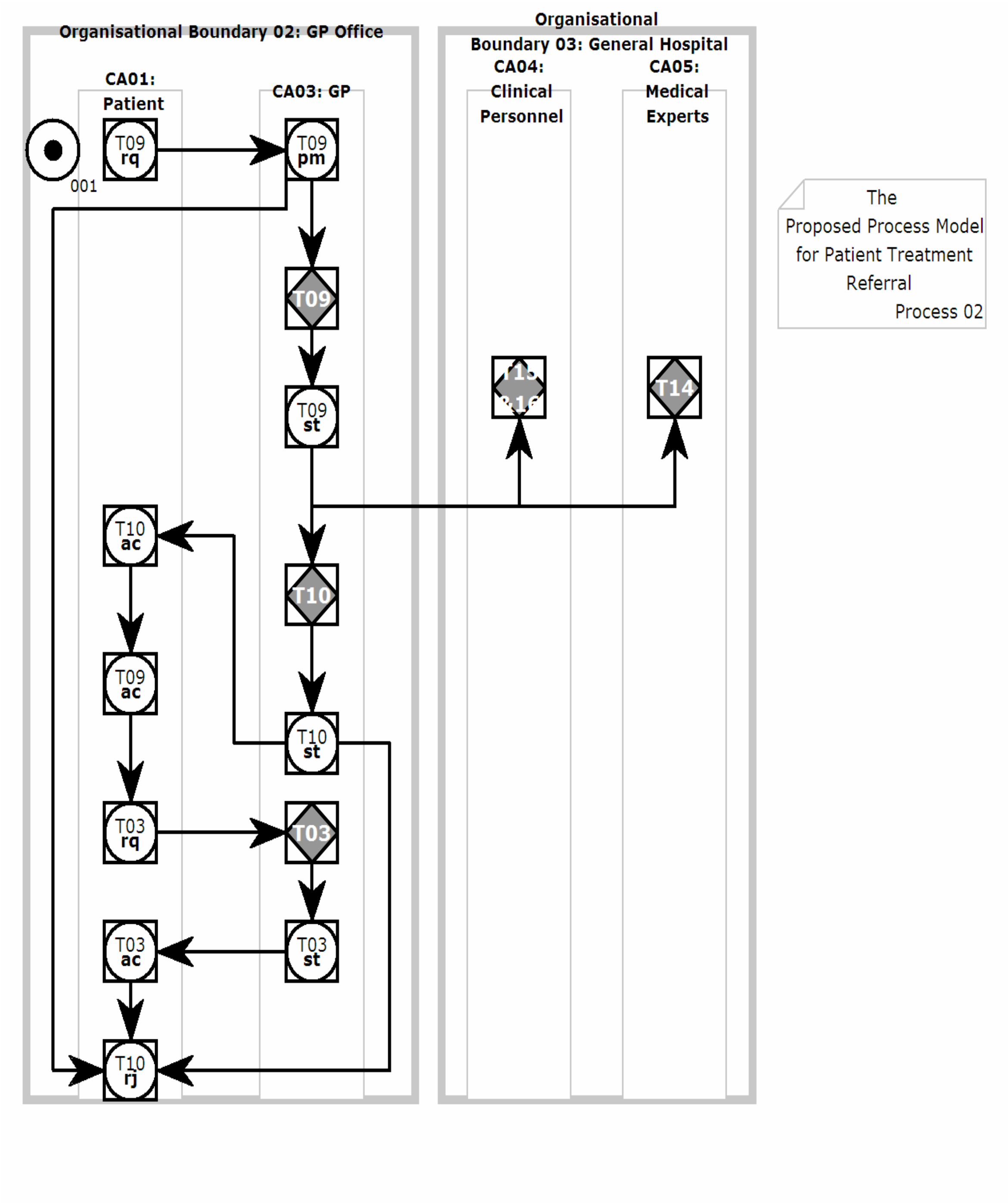


Figure 6.9: The OS Process 02 Model of the Proposed Situation

Finally, all these transactions should be considered efficient and effective based on the following measures. These measures' thresholds will transform acts into facts and ensure the patient orientation of this model. All the relevant action rules of this process are available in appendix 1 of this study.

6.3.6.2.2 Proposed Process 02: Supporting Information System Relevant Measures

The measure proposed for this process is the referral measure number two from the access set of measures at POMR1 Exploded Report (see Table 6.3). The following is the formula for this measure:

✦ **Referral measure (n) = S (n) T03 / S (n) T04**

where n equals number of instances (example: "patient condition") in integer numbers.

Relevant Ontological Processes Figures:

✦ Figure 6.9: The OS Process 02 Model of the Proposed Situation

✦ Figure 6.10: The OS Process 03 Model of the Proposed Situation

This measure tracks the number of patients that received a referral over the number of patients finally admitted in the hospital facilities. That number depends both on the "patient condition" instance that requests the referral and the hospital proposed as a result of this act based on POMR2 value-added (see Table: 6.4: POMR2. Patient Value-added Service Report).

According to the access measurement set presented in chapter eight, and specifically measure two of the POMR1 exploded report, referral measure complies with the patient-oriented standards set by this ontological model. This measure evaluates the quality of each registered public or private GP or any other specialist doctor diagnosis. As the previous measures ensure minimal relevant examinations based on the object class of <bill of examinations> documents which is followed by the call centre, the patient has to be admitted to the hospital with the transaction execution act T04. So, if only a certain percentage of diagnosed referred patients are admitted, that means that either the referral was unnecessary or the specific hospital is unable to handle the patient inflow referred.

The measure could provide two qualitative as well as quantitative results. The first is that specific GPs or other medical experts provide unnecessary <referral> documents to “patient condition” types for any reason. Thus, if their patients’ admission rate is low, further examination is in order. This control could result in referring the patient for further treatment only when it is necessary. The second result relates to the proposed hospitals that could not admit the patients requesting treatment based on <referral> document. This data-logical issue is likely to occur in the best scoring hospitals on POMR1 and POMR2 reports, as the patients prefer them. Thus NHS should strengthen their status accordingly. Finally, the philosophy of this measure could serve a national benchmark time horizon if NHS could provide a specific time frame for a diagnosed patient to be admitted to a general hospital.

6.3.6.3.1 Proposed Process 03: The Redesigned Treatment Process

The redesigned process is the following:

<u>T03ACC: Doctor’s Referral for Further Treatment</u>

Once the patient accepts the transaction’s result of the “treatment referral” document, the next step is the hospital inflow. The patient leaves the doctor’s public office, which is usually the general hospital and communicates with the appropriate clinical personnel. This step is identical to the contemporary situation.

<u>T04RQ: Hospital inflow.</u>

Upon patient request, based on doctor’s “treatment referral”, the clinical personnel inform the patient when the hospital inflow process will occur based on the hospital records as in the current situation analysis. The patient is already aware through “POMR2” and “POMR3” reports, due to doctor’s treatment proposal from core transaction three (T03) and its subs transaction’s about the hospital’s profile.

<u>T04PM: Hospital Inflow.</u>

At this step, the initiator actor “clinical personnel” executes the necessary acts for preparing inflow transaction and registration for accepting the patient condition in the hospital’s records. As the patient is already aware of the hospital’s profile, this means that the lead time for hospital inflow activities is within the time limits of the patient’s condition type.

<u>T04: Hospital Inflow.</u>

As the previous T03 becomes a fact in this transaction phase, the patient registers at the hospital and receives a bed in a room. The patient condition type is considered at an “operational healthcare status”. In order to be considered patient-oriented, this admittance it should comply with the hospital’s measures report of which the patient is aware, as the hospital has to make public these relevant measures according to the “POMR communication record”. Once this act becomes a fact, then the transaction passes to the next act.

<u>T04ST: Hospital Inflow.</u>

At this point the, “clinical personnel” will state the process of the hospital inflow. This statement, due to the previous act of this transaction, makes sense to the listener “patient”, as there is a certain level of awareness that is possessed due to the hospital measures reporting. It is also the hospital’s responsibility to orally provide the necessary benchmarking data and its comparative rating, so that the actor “patient” can understand the level of hospital operation regarding to its condition.

<u>T04ACC: Hospital Inflow.</u>

The informed “patient” will now accept the statement and proceed with the transaction. Alternatively, with the supporting information system at info-logical level, the “POMR communication record”, which is not delivered properly and if the lead time exceeded the patient condition limits, the patient could reject and terminate the specific hospital model transaction.

Thus, at this point the patient is treated in a patient-oriented way if all measures are as expected. Otherwise, in a case of measurements failure the patient rejects the transaction. As the patients do not have the availability of these, the "POMR communication record", and there was no formal NHS information available regarding the hospital's status, there was not a patient-oriented strategy in order. If the measurements are within the acceptable limits, then the result of patient-oriented allocation and registration should be a fact at this point.

T11: Initiation of Patient Treatment Circle.

The actor of this transaction is the "medical expert", specifically the doctor that will be assigned by the public hospital to execute the treatment operation. According to the primary research of this study, if the actor "patient" proceeds with a proposed doctor or any other selected doctor, this act remains the same.

T11 ST: Initiation of Patient Treatment Circle.

It is important that the "POMR communication record" info-logical counselling with reference to safety and malpractice measures is carried out by an actor that will be on the expert team that will carry out the treatment ("clinical personnel" or "expert doctor" actors). The agenda of this act will include an oral, "electronically recorded treatment process" dialogue with the doctor explaining the treatment method to be followed for optimal patient treatment. The quality of information is also subject to the doctor's tacit knowledge, and it could be used in a case where the hospital's malpractice measures are higher than average as the following section will analyse.

T11 ACC: Initiation of Patient Treatment Circle.

The initiator of this act is the actor "patient". Once all the knowledge relevant to its "patient condition" is in order, then the patient should accept the situation and proceed with the next transaction. There is theoretically no chance that the patient declines this act, since the acceptance of the doctor's treatment proposal at an earlier transaction step of this process is in effect (see T04 ACC).

T12: Electronic Verification of Treatment Process and Medical Operations.

The execution of the verification of treatment process and medical operations is initiated without any specific request as a standard operating procedure by the clinical personnel of the specific general hospital to which the patient is admitted.

T12ST: Electronic Verification of Treatment Process and Medical Operations.

The initiator of this act is the clinical personnel who have to deliver the "electronically recorded treatment process". This act becomes fact immediately upon the patient acceptance and the step: T12ACC: Electronic Verification of Treatment Process and Medical Operations.

T18: PM/Execution/ST: Electronically recorded narration of operation methodology.

All of these actions of the transactions are initiated by the medical experts, except for T18 PM that is initiated by the clinical personnel. Analysis of this tertiary operating procedure is outside the scope of this study, as it is directly relevant to the implementation and control of the primary processes included in this ontological framework. It is also concerns the tacit rather than the explicit knowledge of the patient flow that this study aims to analyse.

T18 ACC: Electronically recorded narration of operation methodology

The initiator of this act is the patient. As he/she requires the recorded document of the treatment methodology, the minimum requirement for this transaction results in the patient's awareness of the full treatment circle and medical operations. As the clinical personnel will deliver the recorded documents to the patient, this result is accomplished.

The patient accepts the result of the operation without any reservation, as there is always the potential of reconsidering the doctor's tacit knowledge. That is possible, since the patient, before accepting the result of this process, is already aware of all the medical operations as transaction step, since T18ACC precedes this act (see Figure 10.9).

T17 PM/Execution/ST/ACC: Electronically recorded treatment performance

This standard tertiary process also concerns the actual transaction of the electronically recorded treatment performance. It results in safe medical operation. The initiator of this act is the doctor who is also responsible for:

1. The explicit knowledge of the safety procedures for the patient’s operation
2. The tacit knowledge which is recorded through the standard operating transaction of T19.

In this way, the doctor conditionally turns this act into a fact, if all relevant measures that follow in the next section are in order.

The patient orientation of this process is underscored through this proposed redesign. Aside from the fact that transactions T12, T13, T18 and T19, are novel ones, the hierarchy of these transactions assures patient orientation. The patient is always aware of the next patient flow act in such a way that he/she is able to take an informed decision. Thus, it is not possible for the actor “patient” to leave this process, as he/she has to follow the doctor’s tacit knowledge from T12 transaction until T19 transaction through a recorded document of this flow. In this way, if treatment is not successful he/she could seek recourse in case of malpractice.

The necessary information required for the completion of the reconstructed treated process 03 is represented in the following Information Use Table (IUT). All this information is included in the above transaction phases produced.

object class, fact type, result type	**process steps**
Diagnosed Patient Condition (DP)	T04 RQ
Operated Patient Condition (OP) Treated Patient Condition (TP)	T04ACC T17
Inflow Process Awareness	T04PM
Room	T04ACC
POMR Communication Record	T11ST
Treatment Referral	T03ST
Electronic Verification Treatment Process	T12
Electronic Record of Methodology Electronic Medical Operation Record	T18 T17

Table 6.10: IUT of the Proposed Process 03

All the transaction phases for process 03 are exhibited in the next figure:

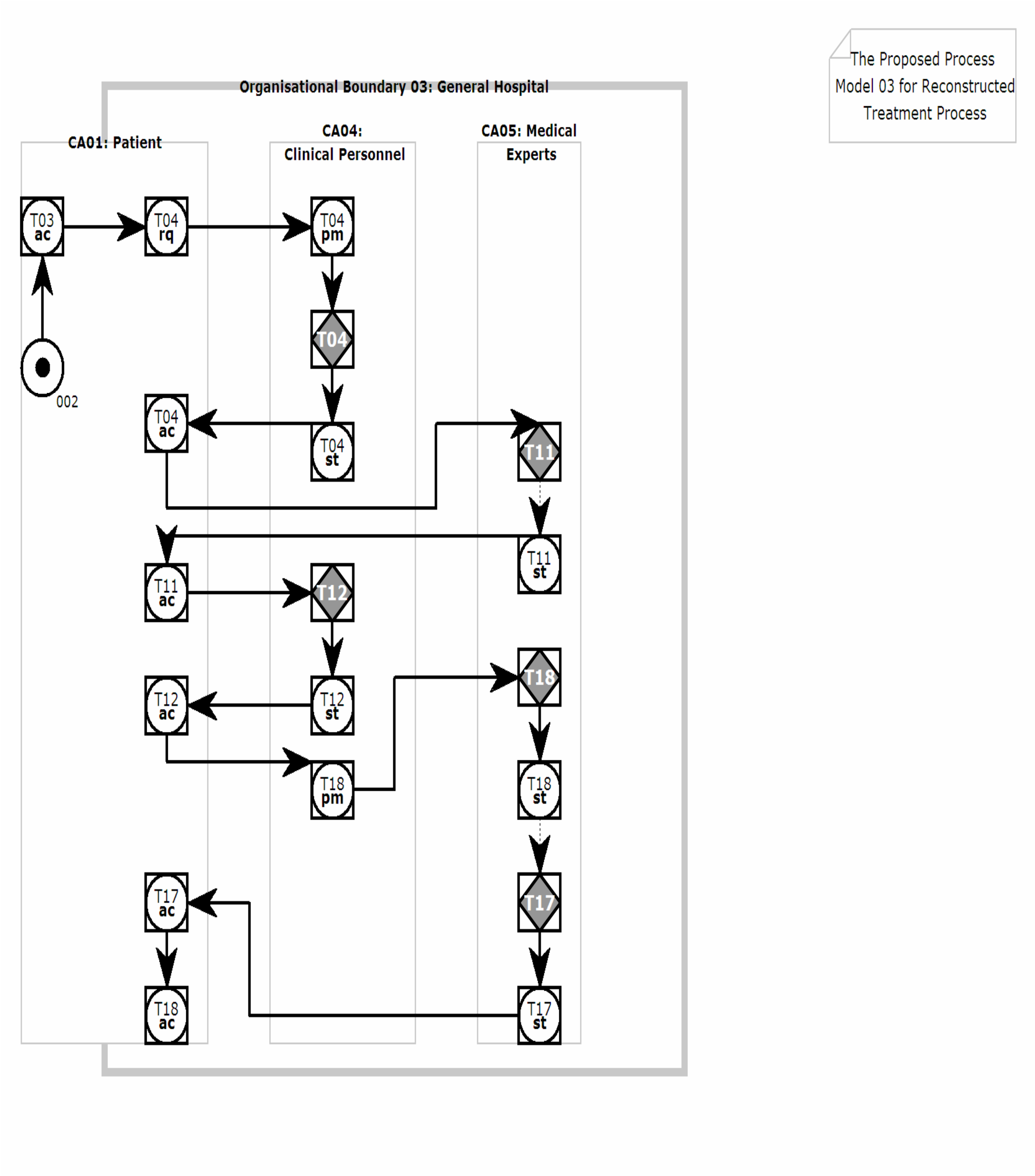


Figure 6.10: The OS Process 03 Model of the Proposed Situation

Based on the above figure, the next section presents all the necessary measures for the process evaluation and analysis as well as each measure’s technicalities relevant to the process.

6.3.6.3.2 Proposed Process 03: Supporting Information System Relevant Measures

There are three measures proposed for this process. The infection measure number three and malpractice measure number four both from the safety measurement set of measures as well as the resource availability measure number six from the structure measurement set (Table 6.2: POMR1 Comparable Report. Patient Condition Collection Measure Comparable Report). The following are the formulas for these measures:

✦ **Infection measure (n) = S (ni) (T12+T17) / S (n) (T12+T17)**

where (n) is the integer number of patient condition types and (ni) is the number infected instances ("patient condition")

✦ **Malpractice measure (nc) = S (nc) (T12+T17) included in POMR4 /**

/ S (n) (T12+T17)

where (nc) is the number of malpractice complaints delivered in POMR4 report relevant question number six.

✦ **Resource availability measure=(hour/day) T04RQ/ (hour/day)T04** where (hour/day) the exact time of the act's transaction occurrence

Relevant Ontological Processes Figures:

✦ Figure 10.9: The Process 03 Model of the Proposed Situation

According to the infection measure number three of the safety measurements set, based on the above ontological process 03, the patient could receive an infection in transaction performance act T12 and T17. In both of these secondary ontological processes, the patients are electronically monitored. T12 is the act that results in the verification of the treatment process preparation and potential minor operations necessary (e.g., anaesthesia) for the patient treatment preparation transaction. This process is electronically monitored so potential infections detected could also be explained. Thus, as a result, this figure delivers a ratio of infections occurring over these two ontological transaction acts which are being delivered accordingly (Table 9.6: The TRT of the Proposed Patient Flow).

In a similar way, the malpractice measure number four of the safety measurements set delivers a ratio of potential malpractices delivered in the secondary ontological acts of T12 and T17, which are electronically monitored. This measure shows patient's impressions regarding a fair treatment circle, which is noted on the POMR4 patient experience questionnaire (Table 6.1:POMR4.The Patient Experience Questionnaire).

The resource availability measure number six of the structure measurements set photographs the exact time of the specific acts that belong to the hospital inflow transaction T04. Thus, this measure not only ensures patient-oriented hospital registration and room allocation, but room allocation that has to occur in a timely manner.

6.3.6.4.1 Proposed Process 04: The Patient-oriented Outflow Process

This proposed process follows the previous third process novel action T18 ACC, which indicates the electronically recorded treatment narration of the methodology. It initiates with the following act:

<u>T05RQ: Hospital discharge and/or rehabilitation treatment initiation</u>
At this point the initiator seems to be the actor "patient", as he/she is already aware of the treatment methodology and should engage in seeking a proper rehabilitation program that ensures the treatment methodology. On the other hand, at the data-logical level proper, object class documents, both administrative and medical for hospital discharge and further treatment rehabilitation, should be initiated by the other system's actors. Specifically, the actor "medical expert" is the actual initiator of this discharge process. The actor "medical expert" delivers the order to the actor "clinical personnel" that the patient is ready for discharge.

T05PM: Hospital discharge and/or rehabilitation treatment initiation

The actor “clinical personnel” should initiate this act of preparing hospital discharge as a standard operating act by a written, timely request for information relevant to this activity by the patient. The informed and prepared actor “patient” should expect the discharge document that usually is enough for full coverage insurance status. At this point, all relevant (object class) information regarding the patient’s rehabilitation program policies and procedures, such as making a hospital appointment for a rehabilitation check up or requesting further rehabilitation instructions relative to the performance methodology, should be properly delivered. In this way, the actor “patient” is both prepared with the necessary documentation required, depending on the “patient condition”, as well as for the statement act of this transaction, where the patient should focus on the medical reporting rather than the bureaucratic details.

T05: Execution of Hospital discharge and/or rehabilitation treatment initiation

The actor “clinical personnel” execute their promise and prepare the necessary “hospital discharge documents” usually as a soon as possible, most frequently without any complications. Due to the hospital’s admittance waiting list, once the previous act becomes a fact, this greatly facilitates the hospital’s inflow by saving precious time. Due to efficient production, it also provides a discharge document that specifies appropriate further treatment proposed by the medical personnel.

T05ST: Hospital discharge and/or rehabilitation treatment initiation

The actor “clinical personnel” initiate this action, as they explain to the patient the “hospital discharge documents” and orally explain and deliver the “hospital rehabilitation procedures report”. The proposed act here is that this document should be formally typed and signed on the hospital’s letterhead form, so that the patient should be in a position to fully understand future communication procedures for treatment. This formal documentation is very important, as formal operating procedures like this act produce clinical process guidelines that assure patient rights during this healthcare flow.

T05ACC: Hospital discharge and/or rehabilitation treatment initiation

The actor “patient” initiates this act by accepting the discharge documentation, which is necessary for the insurance coverage. At this point, patient treatment at the secondary level should be complete, and the discharge documents should be in order.

The patient in this proposal is not obliged to go back to the hospital to clarify bureaucratic details concerning insurance issues. The insurance funds often might require extra examination records, such as x-rays, in addition to the hospital discharge for compensation from certain public insurance funds policies due to procedural changes in policies. Such kind of required documents vary according to the public fund with which the patient is insured. The hospital should be aware of the public administration, and, based on the previous acts, require the necessary documents from the patient ahead of time, so unnecessary patient visits to the hospital after the discharge process for unattained documentation should be avoided. At this point, especially if the patient needs further treatment, an extensive conversation regarding bureaucratic procedures holds no value-added to the patient treatment process. The patient should be concerned about the proper rehabilitation route, if further treatment is in order, based on the “hospital rehabilitation procedures report” received rather than the analysis of the proper discharge process. Thus, this transaction results in a valuable prevention plan for both the patient and the healthcare system.

<u>T13: Execution and T13ST of Proactive Treatment Continuation</u>

Informed about the policies and procedures concerning the possible visits to the secondary level institution from which the patient received discharge documents, the patient should now receive a “generic rehabilitation program” from the rehabilitation personnel with out any further request. This tertiary transaction should be executed immediately, once the patient presents the “hospital discharge documents”. This “generic patient condition rehabilitation program” will be a proposed program of the same object class, formally written and issued by the rehabilitation institution. Specifically, it is a statement of the continued treatment that should be a description of the “generic patient condition rehabilitation program” declaring the proposed rehabilitation program for similar rehabilitation cases that should be followed for completing the treatment circle of the patient. The clinical personnel at this point have now to contact the senior medical doctor from whom the patient received the discharge for customising this generic patient condition rehabilitation program.

T13ACC: Proactive Treatment Continuation

The “generic patient condition rehabilitation program” document gives the idea about the type of treatment continuation that has to be followed both proactively and reactively. Thus, before the patient actually receives the “customised patient condition rehabilitation program”, the “generic patient condition rehabilitation program” document provides the big picture that shows the general rehabilitation framework relevant to the patient’s condition. For example, in this case of a “heart attack” requiring surgery, this document should provide at least information relevant to:

1. The patient diet
2. The patient condition life expectancy statistics under different patient condition rehabilitation scenarios
3. The patient living conditions including physical exercise proposals

Thus, the patient accepts the information communicated that results in a patient condition prevention plan and proceeds to the next act. This proactive treatment transaction is important, as the patient might have to change the specific rehabilitation program due to the dynamic nature of the “patient condition”. The general proactive framework, however, will remain the same, and the patient will be aware of this framework in addition to the changes made in the”customised patient condition rehabilitation program”.

T06RQ: Patient Relationship Monitoring

Once informed of all the secondary and tertiary procedures relevant to his/her condition, the actor “patient” request requests the specific rehabilitation program to be followed.

T06: Promise and Execution of Patient Relationship Monitoring.

As the clinical personnel initiate this act by agreeing with their senior actor “medical expert” to provide a written patient’s schedule of coordinated periodic rehabilitation visits, the “customised patient condition rehabilitation program” document is produced. This rehabilitation document is a schedule that is attached with the relevant specific “hospital rehabilitation procedures report” document. According to the patient record, this act of a proper treatment evaluation is charged to the operating actor, who is the “medical expert”. This actor should prepare a future programmed appointment always in relation to the rehabilitation methodology and the “hospital rehabilitation procedures” document delivered in the previous transaction. At this point the “POMR1 comparable version” updated report (see Table 6.2) should be delivered to the patient. The purpose of this reporting is that the patient understands the level of service received through this healthcare flow. It is important for the new patient to understand where his/her condition stands in relation to the big picture. In the next act, the POMR4 questionnaire will be delivered to the actor “patient” in order to grade its “patient condition” flow experience.

T06ST: Patient Relationship Monitoring

Patient relationship monitoring stated as the “customised patient condition rehabilitation program” is completed and the patient condition is now in “treated patient” condition. The actor of this transaction is the “secretary/call centre”. As the patient is now treated, the “secretary/call centre” actor delivers the POMR4 experience questionnaire for patient flow evaluation. In this way, as the patient leaves the healthcare flow he/she could provide qualitative information through the POMR4 questionnaire for this experience and the quantitative measurements in the “POMR1 exploded version” report all the technical details to complete the relationship monitoring transaction. This transaction results in the verification of the patient rehabilitation. It also assures that this actor is informed regarding the general guidelines relevant to his/her condition from transaction T13.

As a result, it is now possible for any healthcare system to exercise a patient relationship transaction relevant to the national healthcare framework. In any event, the “secretary/call centre” actor is the same actor that manages future entrance of the same or a new “patient condition” to the healthcare flow. So, this call centre with this final ontological act could coordinate proactively and receive information relevant to the healthcare patient flow development from the patients.

<u>T06ACC: Patient Relationship Monitoring.</u>

The patient initiates this act by accepting all the relevant information as well as the POMR4 questionnaire. These acts are delivered by the “secretary/call centre” actor. Once the patient understands this follow-up transaction step, then he/she delivers the POMR4 questionnaire. This actor now, the “patient”, expects to be coordinated in the future by this call centre, as this actor holds all the qualitative and quantitative information of his/her condition.

The necessary information required for the completion of this process 04 is represented in the following Information Use Table (IUT). All this information is included in the above transaction phases produced.

object class, fact type, result type	**process steps**
Treated Patient Condition (TP)	T18
Hospital Discharge Documents	T05RQ
Hospital Rehabilitation Procedures Report	T05ST
Generic Patient Condition Rehabilitation Program	T05RQ
Customised Patient Condition Rehabilitation Program	T06ST
POMR1	T06
POMR4	T06

Table 6.11: IUT of the Proposed Process 04

The above proposed process analysis of this final sub-process is exhibited in the following figure:

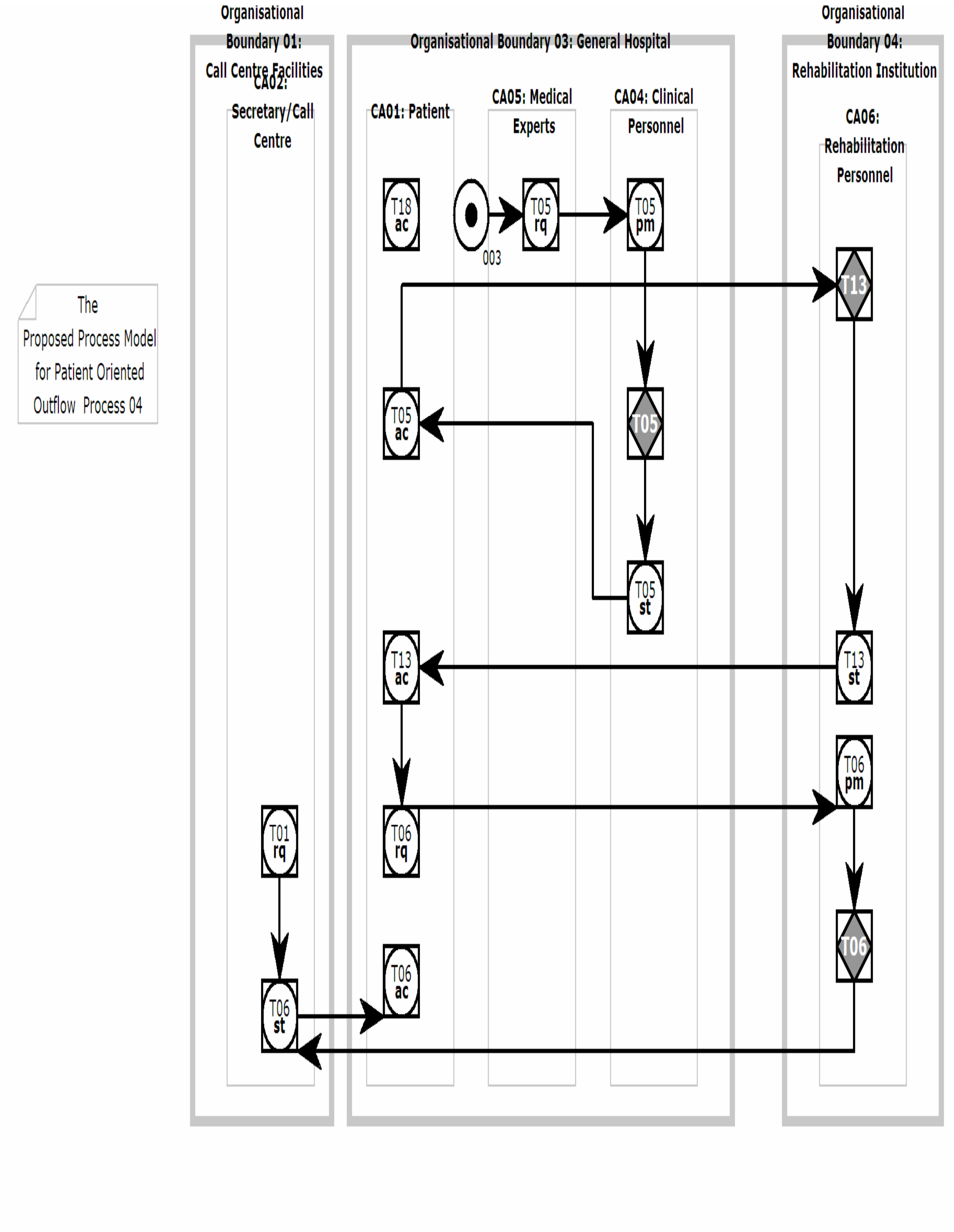


Figure 6.11: The OS Process 04 Model of the Proposed Situation

6.3.6.4.2 Proposed Process 04: Supporting Information System Relevant Measures

There are three measures proposed for this process: the patient experience questionnaire value measure, number five of the structure measurements set, and the fair service effectiveness measure number seven as well as the fair service measure number eight of the outcome measurements set (see Table 6.3: The Exploded Patient Condition Measure Collection Report (POMR1 Exploded Report)). The following are the formulas for these measures:

- **Patient Experience Questionnaire measure**

- **Fair service effectiveness measure = S(n) 18ACC /S(n) T17**

  Where (n) is the number of operations or treatments delivered.

- **Fair service measure = S(n) (T01RQ, T06ACC)**

  where (n) is the number of ontological acts occurring per treated patient

Relevant Ontological Processes Figures:

- Figure 6.9: The Process 03 Model of the Proposed Situation

According to the structure measurements set, the patient experience questionnaire quantifies the integer values of the answers provided. Thus, the level of patient satisfaction could be measured as excellent if the total questionnaire value is 14 units. This means that the patient answered “yes” for all yes and no questions receiving one unit and excellent to the Likert scale ones receiving 4 units. The sum of the answers value according to this chapter’s questionnaire analysis delivers the value of 14. According to the national healthcare framework, the acceptable patient satisfaction level could vary according to national infrastructural parameters researched in the literature review of this study.

The fair service effectiveness measure of the outcome measurements set provides a success rate of the operations performed at the secondary level. This measure counts the number of T18ACC acts occurring over the number of T17 transactions occurring. According to the third proposed patient flow process (see Figure 6.9), in the T18ACC the patient agrees that he/she is treated at secondary level once aware of the full treatment circle that is the result of this transaction. At transaction T17 of the same process, the treatment performance occurs, which is the actual operation that is electronically monitored and its count (n) provides the number of acts performed. Thus, this ratio follows the patient-oriented ontological structure and in addition provides qualitative and quantitative results at the secondary healthcare level (Table 6.6) The Fair service measure of the outcome measurements set proposes a count of all the ontological acts which belong to 18 transactions of four sub-processes and form the redesigned patient-oriented flow process. The ontological model produced proposes a specific patient-oriented ontological flow. If the sum of this measure acts is followed without any loops in the flow, and according to the rules set, then the healthcare stakeholders count measures the exact number of the occurring transactions. As the number of acts is provided with this measure, an activity-based costing accounting model could provide an exact allocation of the cost incurred for this patient-oriented flow. This last measure includes, beyond any doubt, the exact ontological coefficients for such a cost practice.

6.4 Summary

According to this study's literature review, in Greece as well as in other countries, there has been international mobilisation around minimising the public wasted service values in health care. The development of the public sector in Greece in this post-capitalistic era manages the crisis with fiscal austerity policies and exerts pressure towards a patient-oriented healthcare framework in the public sector in order to correct its contemporary inadequacies and quality concerns. Patient satisfaction surveys in Greece are showing that patient-oriented measurements and perspectives are important regarding healthcare services quality redesign.

Based on this study's findings and secondary research, absence of patient satisfaction is usually relevant to organisational gaps. Organisational gaps are related to lack of infrastructure as well as lack of efficiency in organisational and administrative services (Gnardellis and Niakas, 2007). This chapter proposes an ontological approach towards the reengineering of the patient flow. It encompasses the necessary evaluations and supporting tools for the assessment of the efficiency and effectiveness of this ontological structure of the patient flow process. The ontological model constructed assures the core organisational infrastructure's efficiency necessary for the effective evaluation of the healthcare services quality provided. As public dissatisfaction with the health care services in Greece is one of the highest in Europe, the necessity of this ontological model is beyond any doubt (Papanikolaou and Ntani, 2008). The implementation of this ontological model through the CLIPS will provide the necessary knowledge, both explicit and tacit, for evaluating the patient flow in Greece. It will also assist in redefining the national healthcare framework regarding patient satisfaction and treatment. The next chapter will introduce the CLIPS operating system, which will allow revalidating syntactically and practically revalidating the model rules, activities and processes through the simulation of this ontological model flow. This cross validation of the model's technicality also reassures the structural efficiency of the model produced.

Chapter 7 OS Implementation

7.1 Introduction to Data-Logical and Info-Logical Model's Level

According to the 6th step of the adopted methodology of this study (see figure 4.6), once the model redesign is complete then the OS implementation with CLIPS technology is in order. Conventional problem solving computer programs use models and databases to find solutions. Conventional programming languages like C or Pascal are designed for the procedural deliverance of model data. On the other hand, for more complex problems, expert systems are used. Expert systems, which are also known as knowledge-based systems, are computer programs that derive from a branch of computer science research called Artificial Intelligence (AI).They employ common-sense rules called heuristics to support a specific model solution. Expert systems represent the knowledge produced from a model's form or rules or data input. All expert systems have two major coefficients, the knowledge base and the reasoning or inference engine, which will be analysed in the next section (Corcho et al., 2002). They could support redesign techniques as in this study. This supporting information system (POMRS) assists the business-model building techniques, which are used in enterprise ontology, with knowledge engineering deriving from the model methodology of DEMO. Thus, this POMRS, according to the organisational theorem (Dietz, 2006), is the info-logical level supporting the POMR ontological level of this study's model. They are both undivided elements of the novel POMR framework also referred to as OS. In knowledge engineering, the knowledge representation required is derived from the form of the concept and the model implemented. Then, reasoning methods ensure the efficiency of the knowledge representation through the rules of the concept which the model provides. Effectiveness remains to be evaluated in practice.

In this study, the semantic design approach of the expert systems is used due to the ontological nature of the model. There is, however, another approach called the direct approach. The semantic approach begins by using a model's knowledge to characterise and interpret signs or symbols of objects. For example, the expert system CLIPS used at the info-logical and data-logical level in this study uses the ontological to characterise this study's "patient condition service" type (the object), based on measurement results knowledge as patient-oriented or not (the concept or sign). So these signs use metaphors in which the model's functionality could be further evaluated for their efficiency in comparison to the existing concept or sign. Thus, expert systems could deliver the reasoning transaction and provide a specific level of confidence, which conventional algorithms cannot (Giarratano and Riley, 1994). The results of the CLIPS knowledge-based implementation will potentially generate results, which could be used for deciding the proper measurement thresholds for the proper redesign of the patient flow proposed in this study.

7.2 Introduction of CLIPS Expert System

CLIPS 6.23 Version (C Language Integrated Production System) is a software tool written in ANSI C for developing expert systems. Expert systems are programs designed to simulate the problem solving behavioural models of a field of expertise concerning a specified domain and its model methodology (Feigenbaum, 2003). The ontological model designed in Xemod 2008 could be supported by a programming language able to solve complex healthcare situations using the abstract nature of the symbolic sign of this model. This ontological model could hardly be delivered for complete implementation in a conventional language program. Although abstract objects could be modelled in these languages, considerable programming effort is required to redesign the information produced to a format usable with procedural programming models. As a result, the artificial intelligence domain has been chosen in order to allow the modelling of information at a higher level of concept abstraction according to the Dietz (2006) organisational theorem. So, ontology development assists in explicit and formal knowledge representation that can be used and implemented by intelligent systems (Chandrasekaran et al., 1999).

The enterprise ontology domain is a particular knowledge domain that dichotomises the object-and the subject-world and introduces entities in the subject-world involved in relationships with other entities. As these relationships are explicitly analysed in the previous chapter, it is obvious that the scope of shared background knowledge underscoring such interactions among different system's entities can be massive. An example that underscores the massive knowledge parameter of this study in the data-logical and info-logical model is that two doctors (a GP and a medical expert) in the referral process of the model are collaborating to reach a diagnosis at ontological level that combines explicit knowledge based on the systems structure and tacit knowledge based on their expertise.

Ultimately, such knowledge representation should be delivered in languages or tools that allow programs to be built that closely resemble this ontological framework (OS) and its implementation. Therefore, it is easier to develop and maintain programs that could use the explicit knowledge produced together with the tacit knowledge through its database simulation of well-defined problem domains, which are called expert systems. The expert system tools CLIPS will allow to revalidation syntactically and practically of the model rules, activities and processes through the implementation of this novel ontological model flow. This cross validation of the model's technicality also reassures the design efficiency of the Xemod 2008 model design produced. It will also allow potential analysis of the implementation results producing tacit knowledge on patient flow practices. The CLIPS program was designed by *NASA*, which was aiming at building a low cost expert system shell. It is the contemporary predecessor of the existing LISP based systems. Its main advantages relevant to this study's ontological model are:

7.2.1 Speed and efficiency

Rule-based programming is one of the most commonly used techniques for developing expert systems. In this ontological model, rules are used to represent the patient flow and hierarchically specify a series of actions to be performed for each reengineered process. A rule is composed of the "if" part and the "then" part (see appendices). The "if" part of a rule is a series of patterns that specify the ontological coordination acts that are turned into facts based on LAP approach. In the "then" part, facts have to be delivered in order to enter from the coordination world into the production world, which will cause the rule to be applicable. In this ontological model based on LAP principles, once the recipient of the act accepts the provider's responsibility and authority to deliver specific measurable results, the acts become facts of the coordination, and then the production world executes the transaction. The process of matching facts to specific operational acts and producing a transaction pattern is called pattern matching and provides programming speed and efficiency.

7.2.2 Extensibility

The expert system tool provides a mechanism, called the inference engine, which automatically matches facts against act patterns and determines which rules are applicable. The “if” portion of a rule can actually be thought of as the “whenever” portion of a rule, since pattern matching always occurs whenever acts become facts. The “then” portion of a rule is the set of further production actions to be executed according to facts when the rule is applicable. The actions of applicable rules are executed when the inference engine is instructed to begin execution. The inference engine selects a rule, and then the actions of the selected rule are executed, which may affect the list of applicable rules by adding or removing facts. The inference engine then selects sequence rules according to this and executes its actions. This process continues until no applicable rules remain.

7.2.3 The usage of Complete Object-oriented Language (COOL)

The object-oriented approach is used in order to build a model. This latest form of enterprise ontology used through Xemod 2008 in order to build this model is partly based on the object-oriented approach. According to Rambough, et al. (1991) the world is full of objects like the patient condition type that actually express certain behavior like patient-oriented services or not. The object-oriented approach focuses on objects which combine both structure and behaviour, not as revolutionary as ontologies, but they still do combine. So, the incorporated COOL tool encompassed in CLIPS assists the purpose of this study’s model, as it uses objects, like data structures consisting of data fields and methods together with their interactions, in order to design applications and computer programs. Ontology also uses objects and subjects based on its distinct model dichotomy, and thus both the object-oriented approach and ontological approach organize views about the real world. They also follow a similar compact design of engineering systems that could produce certain outcomes. All these similarities facilitated the integration of the ontological model design and its parameters to the CLIPS programming tool.

7.3 CLIPS Expert System Shell

The CLIPS expert system shell refers to the system architecture, which consists of three basic components:

7.3.1 Fact list

The fact list contains the data defined at the start of the program, as well as those defined during runtime. Thus, the implementation of all the ontological rules occurs when initiating the POMRS program in CLIPS by exhibiting all the rules' sequence run. This series of the exhibited ontological rules instantly ensures the error-free technical flow of the model rules produced and the exact manner of their design, according to the ontological model of this study. The usage of such data listing is to exhibit clearly the error-free model at initiation point, so then all the other parameters included in this program, mostly measures, will follow the concept of the model exhibited. The parameters are included in the POMRS reports encompassed and parameterised according to the supporting information system of this ontological model.

More specifically, based on the above fact list, a knowledge base is produced containing the rules that perform inference. Then, the inference engine selects a rule and then the actions of the selected rule are executed according to the knowledge base. Then, according to the knowledge base, the inference engine selects the rule sequence and executes them accordingly. Then, the inference engine is responsible for controlling the execution of the whole program. It contains a variety of conflict-resolution strategies that determine which rule will fire at each step. In this way, it technically evaluates potential conflicts or errors in the ontological rules produced, as otherwise runtime errors occur and the program cannot run. It also assures that based on its resolution strategies, the rules will be followed accordingly. The Syntax of the CLIPS language follows certain fact definitions. In an effort to practically exhibit the syntax nature of this language, the definition of facts is performed in the following Table:

```
(person Akis Papagiannis)
(day Monday)
(flight_time_arrival 18:45)
```

Table 7.1: A CLIPS Fact List

Every fact is a list of symbols, enclosed in parentheses. Facts can be asserted into the fact list via two commands: assert and deffacts. A fact is removed from the fact list by using the retract command. Table 7.1 exhibits that Akis Papagiannis is a person, the day is Monday and the flight time arrival is for a fact at 18:45. Furthermore, a rule has an “if” part and a “then” part. The former consists of prerequisites usually in the form of facts. So, according to the ontological model of this study, once the coordination acts based on the LAP approach turn into facts then the production world fires the rule’s action. This latter set of actions is of dynamic nature, as it could be enriched by new actions that could assert new facts in the fact list. For example:

```
 (defrule rule1
   (burning ?material)
   (material ?material is of type ?type)
  =>
   (assert (fire-type ?type)))
```

Table 7.2: An Extended CLIPS Fact List

The above table infers to the type of fire, based on the type of materials that are burning, as well as the material type. Similarly in healthcare flow this rule would infer to the patient condition service type based on the measurements and their relevant thresholds of the supporting information system evaluation. So, this latter series of actions would assert the program to evaluate based on the data for the type of healthcare service that occurred (see Figure 6.2).

During systems implementation, there might be a potential case where the ontological acts satisfy more than one rule. That might happen at the implementation stage when new rules are inserted in order to capture potential dynamic changes of the healthcare industry. In such a case, there are two solutions provided in the POMRS proposed. The first solution is applicable at the ontological DEMO model’s level and the second at the CLIPS programming level. At the ontological model's level, such an issue could be resolved due to the transaction hierarchy proposed at primary, secondary and tertiary level (see Figure 6.6). This ontological hierarchy proposed is unique and defines the exact sequence of the transaction model, so there is no need to initiate the conflicting rules option of

this POMRS framework, although it is possible. If such a case is in existence, more than one rule whose prerequisites are satisfied, all the conflicting rules are inserted into the conflict set and one of them has to fire. This was a very important program option for selecting the CLIPS program. Thus, in any case, the POMRS supporting information system extension could be potentially also supported by the prevailing rule. The prevailing rule is determined by priority rule as well as the conflict resolution strategy.

Rule priority is defined through the salience declaration. The salience declaration was another important feature that is directly relevant to ontological model of this study, as it relates to resonance and potentially to semantic resonance. Resonance, through the salience declaration, makes the supporting information system more pleasant for the user and as the evaluation chapter will exhibit, the parameter of the system's usability is greatly enhanced. Resonance of users refers to the interaction between the user and the model prototype. It is a rather unexplored area, due to its complexity. Why do some users resonate with certain products while other do not? What are certain guidelines for enhancing the model design that respect the human-centered critical success factor of this study's literature review? Thus, through the primary and secondary research of this study it is obvious that the resonance played an important role for the practical design of POMR of this model. The salient aspects between the system's actors and the model's design provide answers to the above questions. As for the conflict resolution strategies, the CLIPS features seven strategies, which are set by the set strategy command. The list of strategies includes:

1. Depth, which concerns the newly inserted rules that will fire before the older ones
2. Breadth, which concerns the newly inserted rules that fire after the older ones

3. Simplicity, which refers to rules with simpler prerequisites that will fire before the more complex ones
4. Complexity strategy, which refers to rules with simpler prerequisites that will fire after the more complex ones
5. Lex, which is the combination law strategy that refers to the interaction between depth and complexity
6. Mea, which is the strategy where the rule with the most recent prerequisite fires first
7. Random rules strategy fires rules in a randomly order

The above list of conflict resolution strategies provides useful tools for programming flexibility, which is necessary for complex models similar to this study's. Another tool that supports programming based in object-oriented style, is COOL (CLIPS Object-oriented Language) which offers to abstraction, encapsulation, inheritance, polymorphism and dynamic binding, namely all the primary characteristics of object-oriented programming. A new object class is defined via defclass. For example, the vehicle class could be defined as follows:

```
(defclass vehicle
   (is-a USER)
   (slot fuel-type (type SYMBOL))
   (slot tank-capacity (type INTEGER))
   (slot fuel-loaded (type INTEGER)))
```

Table 7.3: CLIPS Object Class Example

A specialisation of the above class is car, which inherits parameters from vehicle, but also features new slots:

```
(defclass car
   (is-a vehicle)
   (slot consumption-rate (type FLOAT))
   (slot reset-able-counter (type INTEGER)))
```

Table 7.4: CLIPS Object Class Example with New Slots

Class instances (objects) are defined as follows:

```
(make-instance [truck1] of vehicle
   (fuel-type diesel)
   (tank-capacity 100)
   (fuel-loaded 50))
```

Table 7.5: CLIPS Object Class Example with Instances

The above table of instances can be modified by creating and removing instances and by the retrieval and alteration of the slot values by using the send function.

All the above tools and strategies as well as object-oriented principles conclude the CLIPS architecture structure, which was realised for the implementation of the Patient-oriented Management and Reporting System (POMRS) This POMRS supports the POMR ontological model. They are both undivided elements of the novel POMR framework also referred as OS.

7.4 OS Implementation

In order to demonstrate the flow of processes for the proposed framework, a CLIPS-based expert system was created. The choice of an expert system for the given task is justified by the fact that each process is based on a number of rules, where the consequents of one rule are prerequisites for another, and so on. The CLIPS, which was specifically selected over other rule-based systems because of particular advantages the software offers, is exhibited in the previous sections. The OS to implement by running the ontological model rules of this study contains the knowledge base of the healthcare flow in the CLIPS file "pat.clp". The following subsections describe its main ingredients.

✦ Classes and Objects

Initially, the patient class is defined, which contains a number of slots: patient-name (the name of the patient), patient-pid (public insurance data), patient-mh (medical history), patient-fe (are further exams needed?), patient-pd (preferred appointment date). The definition of the class of patients and the object class parameters relevant to patient condition implemented at data-logical level is included in the following Table:

```
; Patient class
(defclass patient
        (is-a actor)
        (role concrete)
        (pattern-match reactive)
                (slot patient-name (type SYMBOL));name of patient
                (slot patient-pid (type SYMBOL)) ;public insurance data
                (slot patient-mh (type SYMBOL))  ;medical history
                (slot patient-fe (type SYMBOL) ; further exams needed?
                        (allowed-symbols yes no)
                        (default no))
                (slot patient-pd (type SYMBOL));preferred appointment date)
```

Table 7.6: OS Classes and Objects

A sample instance of the class of patients is created [patient 1 or p1] in the following Table:

```
; Instances of patients
(definstances patients
        (p1 of patient (patient-name Papagiannis)
                (patient-pid 99922002)
                (patient-mh ok)
                (patient-pd 1/12/2010)))
```

Table 7.7: OS Patient Instance

According to table 7.7, patient instance named Papagiannis with patient id number (named “AMKA” in Greece) has an updated patient record, as the ontological model requests at the patient-oriented process 01, and thus the ontological transaction of making an appointment on a requested date is implemented. A series of instances of selective patients could make an appointment following the above Table’s 7.1 instance rule.

As far as the LAP approach acts are concerned, they have to be fulfilled as facts passing from the coordination (C world) to the production world (P world) according to the ontological model’s patient-oriented process 01 rules encompassed in the CLIPS file “pat.clp”. Then the facts are fired. Initially, only a single fact is inserted into the fact list (T01-RQ), representing the LAP approach request on behalf of the patient for any type of appointment.

```
(deffacts startup "Initial Facts"
        (T01-RQ))
```

Table 7.8: OS T01-RQ: Patient Appointment Request

During runtime, ontological rules' prerequisites are satisfied, and the respective model rules fire, resulting in new facts asserted into the fact list. All the facts have a certain format: (<process>-<activity> <participating-actor>), which denotes that a certain activity, belonging to a respective process is performed by the participating actor according to the above Table's exhibited syntax. Such sample facts are: (T01-PM ?x), (T02-RQ ?x) and (T16-RQ ?x). Variable?x denotes the participating actor. The newly inserted facts serve as prerequisites for the rules that fire.

The "if" part of the rules that represent preconditions or prerequisites contain facts of the above Table's format that represent accomplished processes. When the "if" part is satisfied, the rule fires and produces the results called rule consequents or antecedents, which are described in the "then" part of the rule. The results are usually newly-derived facts, inserted in the fact list. There are certain rules that also need additional verification before firing, e.g., check patient's insurance status. These secondary sub-processes, which follow the DEMO ontological model (see Figure 6.6), are described in complementary functions in the next subsection. A rule sample is the demonstrated on the following Table:

```
; On requested T01 appointment AGENDA
; ACTIONS
;    If <insurance status> (IS) and <EPR> (R=Record) complete
;    then promise T01
;    If not <insurance status> (IS=Insurance Status) complete
;    then decline T01
(defrule rule-1-1
        (T01-RQ)
        (object (is-a patient) (name ?x))
 =>
        ; Checking insurance status for patient
        (check-insurance-status ?x)
        ; Checking EPR for patient
        (check-epr ?x)

        (assert (T01-PM ?x)))
```

Table 7.9: An OS Ontological Rule Sample

As mentioned above, there are various functions that validate certain conditions, before allowing a rule to fire, namely, a process to proceed. For instance, in the rule presented in table 7.9, check-insurance-status and check-EPR are two such functions. The former checks the patient's insurance status, while the latter checks the EPR. All the functions in the implementation are simulations, meaning that they always have to return a positive result, if the ontological structure rules are correct, i.e., the checks always succeed. Of course, in a real life implementation, the system would have to perform actual checks, which also have the potential to fail due to the rule's requested facts. This means that, if the thresholds of the measurements included in the performance network or the data-logical documentation are not satisfied, then the patient flow lacks the prototype's ontological systems design and patient-oriented issues arise for further examination. On the other hand, the measurements thresholds are beyond the aim of this study, as they are set by the external healthcare environment (NHF). Therefore, in this system, implementation of the model "dummy" functions is created to simulate the patient flow. Both these "dummy" functions are represented in the table below:

```
;;;DUMMY FUNCTION - always returns true
; Check insurance status for a patient. Two things are checked:
; - Updated yearly insurance examination booklet
; - No outstanding insurance payments
(deffunction check-insurance-status (?x)
        (return true))
;;;DUMMY FUNCTION - always returns true
; Check EPR for a patient. Two things are checked:
; - All relevant exams completed according to <bill of examination>
; - Prior <Patient condition> complete
(deffunction check-epr (?x)
        (return true))
```

Table 7.10: OS "Dummy" Functions

In order to demonstrate the cross functionality of the developed rule based system, a simple graphical front end was implemented in Java (JFC/Swing). The Graphical Users Interface (GUI) produced in the next section assists in executing the simulation, watching the output results and observing the performance valuation measures.

7.5 OS Requirements Technical Evaluation and Generation

In order to run the OS implementation, it is necessary for the target computer to have the Java Runtime Environment (JRE) installed. Thus the JRE can be downloaded from Sun at http://www.java.com/en/download/index.jsp. The demo also requires CLIPSJNI which is electronically available at http://clipsrules.sourceforge.net/CLIPSJNIBeta.html, a Java Native Interface for CLIPS for using the CLIPS environment from within the Java Virtual Machine (VM). However, CLIPSJNI is already available in the demo folder and no further action is required on behalf of the end user. The implementation run is launched, by double-clicking on the “run.bat” file, contained inside the attached electronic folder of the supporting information system (POMRS).

The implementation development environment was generated in NetBeans (v. 6.5), a popular open source Integrated Development Environment (IDE) for software developers. NetBeans also features a flexible Java GUI builder, which allows designing GUIs by dragging and positioning components from a palette onto a canvas, and the program automatically takes care of the correct spacing and alignment. The GUI builder is intuitive and customisable, comes with pre-installed Swing and AWT components, and includes a visual menu designer. The generation of the following screens technically verifies the cohesive structure of the ontological model, and, once the knowledge base is evaluated, then the next screen is produced (see Figure.7.1).The screenshots encompassed in the POMR are exhibited in the following figures. These figures are the exact same Tables exhibited in the previous chapter as POMR1, 2, 3 and 4, which measure the patient quality service. The initial window of the software is seen in the following figure:

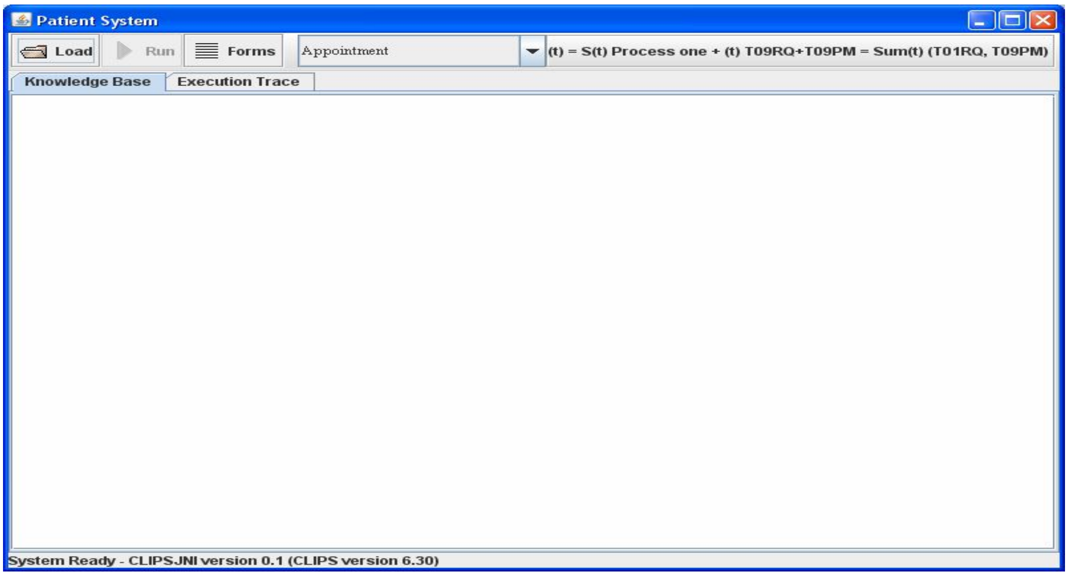


Figure.7.1: Initial window of the Supporting Information System

The above window consists of:

- The toolbar, where all the primary system functionalities are launched from
- Two tabs in the middle, which display the knowledge base as well as the execution trace
- A status bar in the bottom that displays information and various messages.

Of course, the window of the software also offers the rest of the usual Microsoft-like “functionality”, as minimizing, maximizing and closing the window. The POMR functionality refers to the following widgets which are featured in the toolbar (see Figure 7.2)

The “Load” button is used for loading by running the knowledge base implementation (CLIPS file “pat.clp”). Upon loading the file with all the ontological model rules, the knowledge base appears in the central part of the main window of the program “Knowledge Base”. The user can only view the file and no modifications are currently allowed for ensuring the original ontological model of the flow.

Figure 7.2: The Supporting Information System Toolbar

The “Run” button is initially disabled, but is enabled only upon successful loading of the ontological model’s knowledge base.

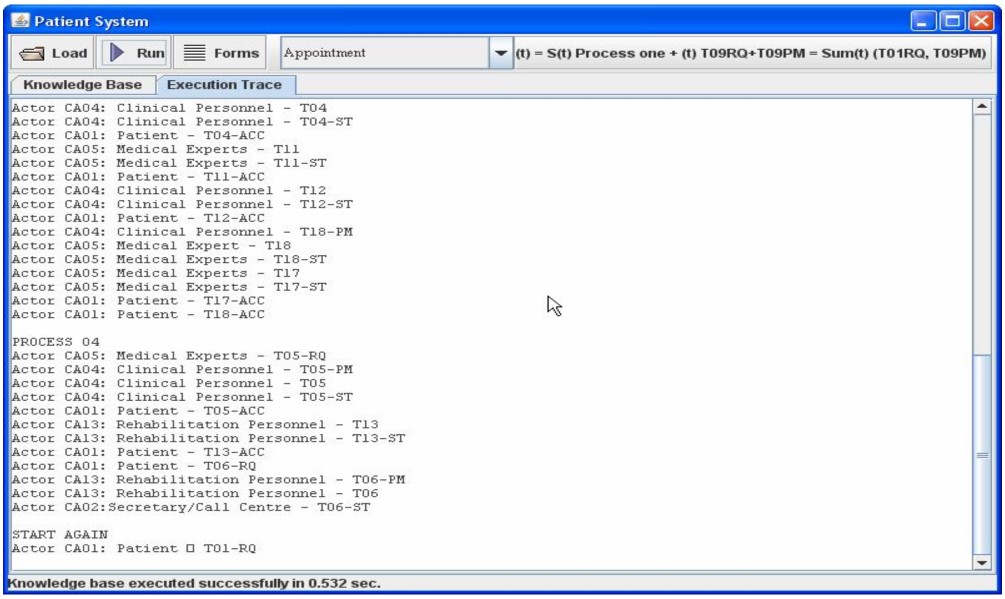


Figure 7.3: The Supporting Information System Knowledge Base

When the user presses the button, the rule base is launched and the rules are executed. Once the knowledge base is successfully executed, then the implementation results of this execution appear in the main window, under the tab “Execution Trace”. The results of this execution are also stored in “export.txt”, so that the user has the option of viewing and possibly modifying them only outside the environment of the developed prototype system (OS).

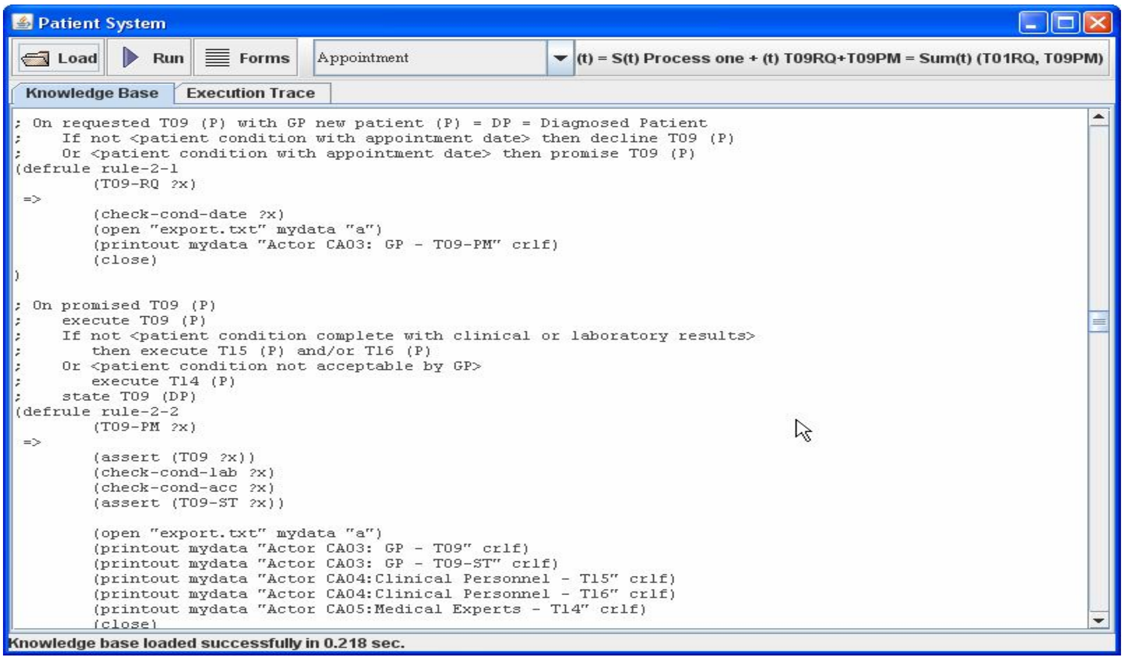


Figure 7.4: The Supporting Information System Execution Trace

The “Forms” button displays all the appropriate forms like the next figure of the “POMR1: Patient Condition Collection Measure”

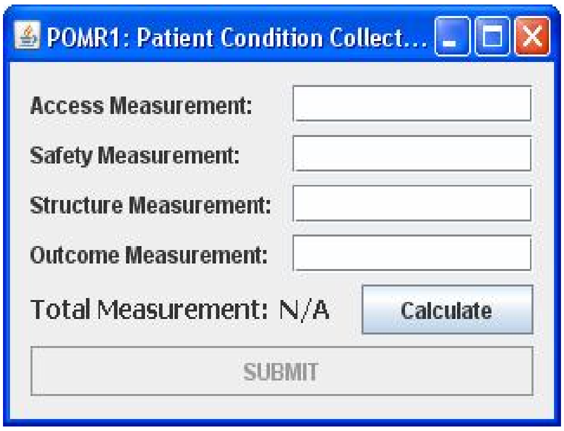


Figure 7.5: “POMR1: Patient Condition Collection Measure” Screen

The next figure presents the “POMR2: Patient Value-added Service Report” screen:

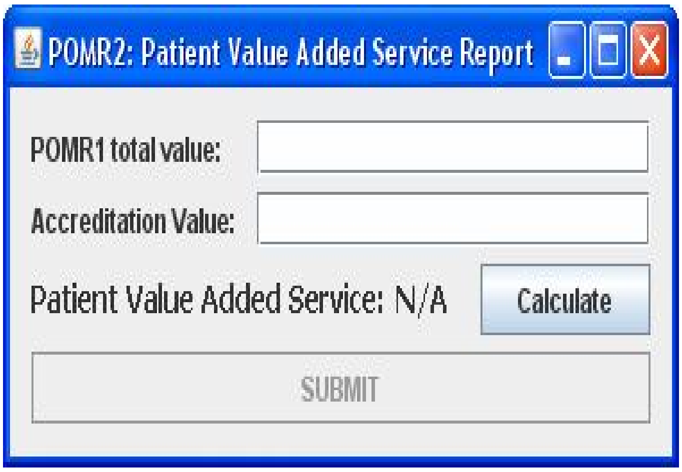


Figure 7.6: “POMR2: Patient Value-added Service Report” Screen

The reporting system of the evaluation framework continues with the “POMR3: Patient-Hospital Performance Report” next:

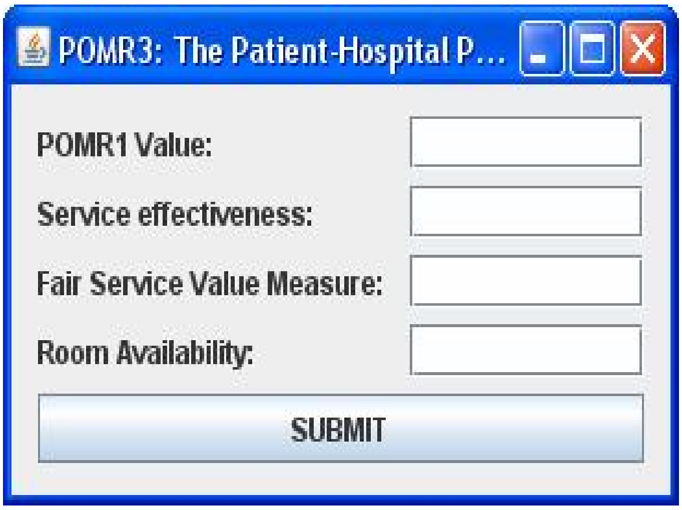


Figure 7.7: “POMR3: Patient-Hospital Performance Report” Screen

The last screen of the POMRS evaluation framework function included in the ontological structure of this flow is the “POMR4: Patient Experience Questionnaire”.

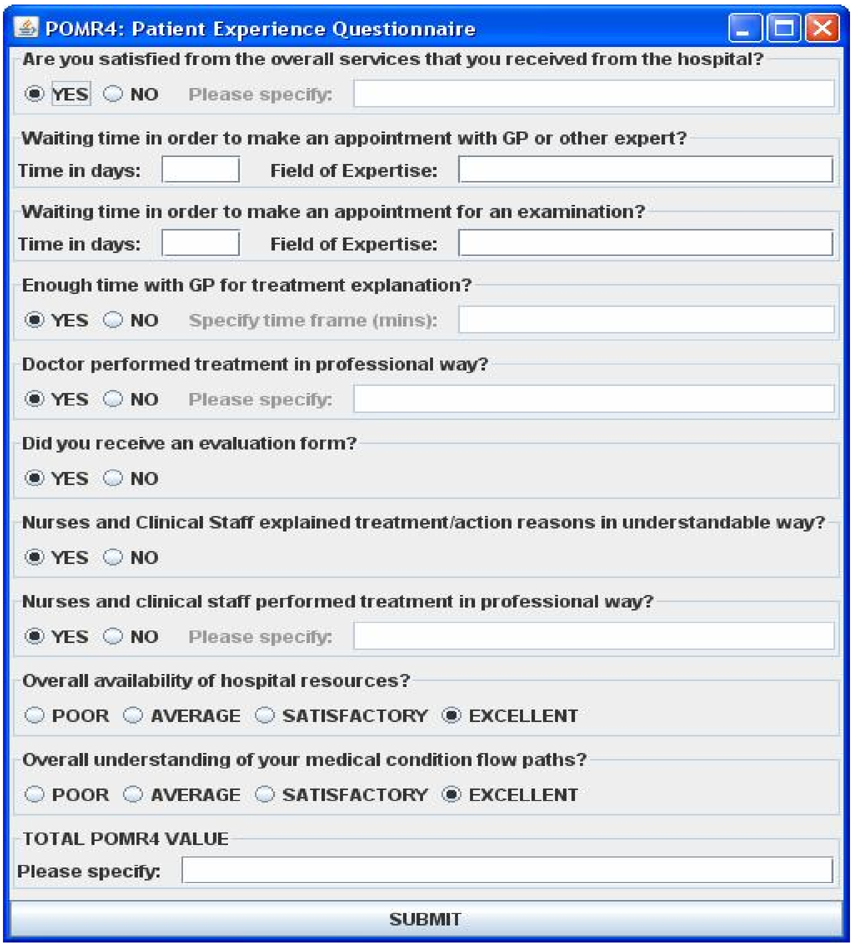


Figure 7.8: “POMR4: Patient Experience Questionnaire” Screen

The systems users vary according to the report produced and are analytically exhibited in the previous chapter. The users are offered the capability of filling the forms in online and then submitting them to the POMRS operating system. All questionnaire answers are stored in separate files, called “pomr1.txt”, “pomr2.txt”, “pomr3.txt” and “pomr4.txt”, respectively. The answers are stored in textual format and can be later retrieved for further processing (e.g., statistical analyses etc.).

Finally, the measures and their screens of the OS, demonstrated according to the adopted methodology (see figure 4.6) and the above figures, represent the available ontological measures and serves no further functional purpose. Their generation assures the technical evaluation of the POMR ontological model as proper program syntax of rules is required for their generation.

7.6 Summary

According to this novel framework implementation, the user could enter or have access to the following supporting information system measures at data-logical and info-logical level: “Appointment”, “Referral”, “Infection”, “Malpractice”, “Resource Availability”, “Patient Experience Questionnaire”, “Fair Service Effectiveness”, “Fair Service”, which are functionally consistent with the ontological model of this study and expressed and implemented through the CLIPS technology of the supporting information system named POMRS.

Based on this tacit knowledge, the OS redesign is implemented according to the white box structural model decomposition of the US introduced in the 2nd step of adopted methodology and the BB functional model realised in CLIPS of the OS introduced in the 6th step of adopted methodology (see Figure 4.6). So, this OS simply introduces a hierarchical series of specific, ontological transactions design and its supporting information system’s measures for the implementation of this study’s concept.

This study focuses both on quantitative and qualitative internal and external issues, as it redesigns a novel ontological model of patient-oriented flow that will be ensured through the proper patient-centred measurement system's novelties implemented in CLIPS. This study's leading proactive nature of the supporting information system (POMRS) takes into account the external environment of the healthcare industry, but it does not dictate any specific structural solutions for the POMR framework (OS). It could be a useful consulting tool for national industry's future trends, based on evidence of this novel OS results occurring from the framework redesigned. Finally, the level of patient satisfaction and treatment will be measured through the patient, value-added service formula previously exhibited according to the set of measures presented in this study. The next chapter will focus to the evaluation study of this framework, which is assisted by this study's interviewees, and any corrections or improvements proposed by them as evaluators will be taken in to consideration before this framework's final review.

Chapter 8 OS Evaluation

8.1 Introduction

This chapter is about the evaluation of the OS, a framework design and implementation of this study's patient flow concept. Conceptual approaches modelling is expressed through conceptual range of modelling approaches that have been adopted according to a methodology in order to express in conceptual terms the issue of modelling healthcare management (Friedman and Wyatt, 1997). This framework is based on conceptual modelling, which is expressed with the semiotic triangle (Figure 6.1) and the ontological parallelogram (Figure 6.2) of this study. The DEMO methodology was adopted for this redesign in order to functionally measure the patient condition-level service type aiming at the concept implementation of this study. The OS implemented defines the quality of the healthcare service delivered, based on proactive measures, which are introduced at info-logical level to specific ontological transactions, which are designed based on data-logical documentation in a unique ontological hierarchy. The OS implementation could deliver the potential measures result of every instance entering the ontological framework of this study. The purpose of the OS is directly relevant to the aim of this study, which is to redesign and measure patient satisfaction and treatment of the patient flow in a patient-oriented way.

On the other hand, the need for effective public health provision to capture the essence of the multi-attribute, multi-variable, multi-perspective nature of the public health structural problem is complex and is beyond the aim of this study. According to Cohen (2002) "clinical and technical advances in healthcare delivery attract the most attention, it should be underscored that the most difficult issues to deal with are the social, economic and political ones," which are expressed through the conceptual approach of this study.

The need for evaluation study is vindicated by Friedman and Wyatt (1997) by identifying the reasons for implementing such a study in the field of medical informatics. First of all, promotional reasons encourage the future use of the OS as its coherence, practicality and extensibility of its design are ensured through this evaluation study. Scholarly reasons raise the use of the enterprise ontology and its DEMO methodology for developing knowledge based systems, providing measures from improvements in the field of medical informatics and measurements. Ethnical reasons make sense, if an investment decision towards realistic implementation of the OS is effective. Pragmatic reasons justify the effectiveness of this study as other contemporary frameworks fail to currently satisfy the aim of this study. Ultimately, methodological reasons reduce the liability risk, as future system users are in need of the evaluation results, in order to exercise their professional opinion using this OS. The evaluation study is planned considering that the aim of this chapter is to define the appropriate evaluation methodology and then use it in order to asses the quality of the OS. This chapter's objectives are the following:

1. Research for related literature for evaluation
2. Identify the suitable methodology
3. Analyse and examine the proposed methodology components
4. Asses the appropriateness of the methodology with OS
5. Propose and describe the proper evaluation methodology
6. Evaluate OS using the selected methodology

8.2 Models and Systems Evaluation

The importance of systems evaluation is a prominent issue for many researchers and managers, as, historically, the introduction of novel information technology is often perceived as a threat in the organisational design (Davenport, 1993). So, qualitative scientific evaluation is necessary in order to avoid system implementation problems. As defined by the American evaluation association "evaluation involves assessing the strengths and weaknesses of programs, policies, personnel, products, and organizations to improve their effectiveness" (www.eval.org). Related to the aim of this study, evaluation is relevant to "trying out and assessing new program designs determining the extent to which a particular approach is being implemented. Developing or selecting from among alternative design approaches, for example, trying different curricula or policies and determining which ones best achieve the goals" (Muraskin,1993). According Rossi and Freeman (2004), another more recent relevant definition, evaluation "is the systematic application of social research procedures to judge and improve the way information resources are designed and implemented".

In any case, according to the above definitions, a careful study that will raise the bad or good system's quality would support the decision about the OS value. According to Opperman and Reiterer (1997), systems evaluation is relevant to the level of the system's usability defined as a system's effectiveness, efficiency and user satisfaction. Historically, according to Cohrane (1972), efficiency and effectiveness are two healthcare industry values, which are essential to all healthcare services design. Effectiveness is relevant to the system's aim and realisation of its objectives and efficiency is relevant to the proper use of the resources in order to attain the system's aims and objectives and the level to which users find the system useful refer to user satisfaction. Thus, historically, the level to which a certain system or framework satisfies the above parameters is the way that the OS is evaluated. The features of the OS that are relevant to its quality are defined "system quality", those relevant to its produced result are defined as "technical quality", and the manner that the systems usage enhances users production is defined as "usability".

The evaluation level of this study is important, as it will try to reveal any potential issues that have to be resolved before its actual implementation. It is therefore important to carry out this study's evaluation clearly in order to prove the value and the quality of the OS. It should also provide confidence for the users that such a redesign will actually improve the healthcare flow towards patient treatment and satisfaction in a practical, efficient and effective way. Thus, in an effort to define the evaluation study, clearly the OS parameters that affect its quality must be recognised and then analysed in order to form this evaluation study.

8.3 Review of Evaluation Methods relevant to Clinical Information Models and Systems

The research volume on models and systems evaluation is vast, underscoring the importance of system evaluation as a conceptual model. A number of ontologies used in clinical information systems have been developed or enhanced with description logic representations to permit explicit inferential use in the ontological domain. Projects include the Gene Ontology Next Generation (GONG), which is a Methodology to Migrate the Gene Ontology to a Description Logic Environment using DAML+OIL; it is a project that is similar to protégé project as described in chapter two (Wroe et al., 2003) as well as SNOMED-Clinical Terms, which is supported by TSDO that is a non-profit association that develops and promotes use of SNOMED CT. TSDO and supports safe and effective health information exchange (www.snomed.org). Finally HL7, as explicitly presented in the literature review of this study, and the National Cancer Institute Thesaurus (NCI) are also two clinical, information systems relevant to ontologies.

Many evaluation techniques have been introduced for evaluating ontologies relevant to clinical information systems. They mostly focus on the knowledge representation efficiency and trade-off between the value of high expressivity and the cost of computation. Focus on high expressivity is manifested, as presented in chapter four, by semantic web emphasis and the WOSL (World Ontology Specification Language) that is related to the enterprise ontology theory and DEMO methodology, as it contains designs necessary for the Xemod 2008 software introduced. Due to the philosophical and dynamic nature of enterprise ontology, other existing languages like DOGMA and GOL were not preferred (Dietz, 2006). Any evaluation of ontology has to evaluate the expressivity of the knowledge representation language used. The ontology to be evaluated should also be mapped at the ontological level or upper ontology that will define the construction model parameters in relation to class, properties, relations, state and hierarchies (Sider, 2002). Thus, ontology evaluation must consider the quality of the upper evaluation and the reasoning that occurred between the prototype and the user. Then, the evaluation of the supporting information system's knowledge-base of the ontological model should be able to provide a complete picture of the concept in a consistent way (Dietz, 2002). All the above parameters are relevant to Clinical Information Systems evaluation. They all start at the ontological level, they are supported at info-logical level and data-logical

level, and they have foundations in the philosophical base that of the model's conceptual design (see Figure 6.2).
On the other hand, for the selection of methodologies for ontological evaluation one should consider the three basic categories of ontologies as referenced in chapter four of this study. A major ontology systematic evaluation method that is required to transform ontology engineering into an absolute scientific and engineering discipline will take into consideration the representation of individual ontologies, performance and accuracy on tasks for which the ontology is designed and used, degree of alignment with other ontologies and their compatibility with automated reasoning (Obrst et.al. 2003). Such evaluation methods are directly related to the first category of ontological methodologies, which, according to chapter four, focus on building ontologies with models like the Noy and McGuiness one. Another ontology evaluation method of this category is the Onto-framework, which focuses on Methods Engineer (ME), which aside from the fact that they are inadequate to solve practical problems provide evaluation frameworks primarily for scientific, model design (Leppanen, 2005). Thus, although they are conceptually close to this OS, the evaluation methods of this category do not take into consideration the redesign step of the adopted methodology as well as the concept of General Enterprise Modelling methodologies (GEM) that are directly relevant to this enterprise ontological framework.

Other evaluation methodologies according to chapter four are relevant to the third category of ontology development. Much like other general software development methodologies according to Kumar and Smith (2003) they focus on semantic agreements which humans are trained in a set of guidelines for how to label examples in terms of categories, and the richness of these guidelines (e.g., Gene Ontology).

In conclusion, this enterprise ontology modelling of this framework (OS) is a conceptual representation of the ontological model's activities, transactions, information, tangible resources (object class), actors, behaviour patterns, strategic aims and objectives and finally constraints and flow patterns based on the OS action rules (Gruninger and Fox 1995). Thus, the ontological nature of this study contains certain philosophical bases for evaluation which must be a priori fundamentally reviewed. General Enterprise modelling evaluation methods directly relate to the nature of this study, which belongs according to chapter four to the second ontological category and is related to redesigning, evolving and maintaining ontologies.

Finally, it must be noted that the philosophical evaluation base of this study is neither of objectivist nor subjectivist nature. Objectivists would technically evaluate a system standard, based primarily on statistics, believing that the world they live is a world fully dependent on them. Subjectivists believe the opposite: that there is no reality in any evaluation methodology that is based on anything besides a true objective reality. This means they do not believe anything outside the object class of “patient condition” relevant attributes of this study. The nature of this study is a constructivist one. Constructivists agree with the subjectivists that there is no absolute objective reality as the objectivist believes, but constructivists believe a kind of semi-objective reality called inter-subjective reality, and it is expressed socially through the LAP communication principles presented in this study. Thus, this evaluation study must take into consideration that enterprise ontology design could be devised, redesigned and adapted to any external environment, and based on this philosophical base it cannot be otherwise. The LAP communication encompassed in this model’s methodology provides a functionalist nature, which considers social and political issues in healthcare organisations which, according to Cohrane (1972), are important as equality as well as efficiency and effectiveness must be considered. So, the philosophical evaluation base to be considered is the constructivists’ one. Thus, this study’s adopted methodology of Gruninger and Fox (1995) should be fundamentally evaluated based on the philosophical approach of the constructivists.

There are, however, several studies evaluating methodologies for Systems Development regardless of the industry profile. The consideration of all these studies increases productivity, communication and user involvement (Fitzgerald, 1998b). This OS, however, has fundamentally to:

1. Satisfy the constructivists approach as an OS that serves the redesigning process of the patient-oriented healthcare flow

2. Satisfy the functional problem solving process design issues of the healthcare quality flow

3. Satisfy the decision-making process based on the supporting information system

4. Satisfy the learning process, which will occur from the knowledge base that stores all OS implementation data

Thus, there are all these different conceptions about the nature and purpose of this study. As this framework does not start from scratch as it redesigns the contemporary healthcare flow, the critical review for evaluation methods in the healthcare environment that has to be implemented should be based on the above parameters, which are philosophically and fundamentally set.

In the literature, one can identify numerous other models and measures. Delone and Mc Lean (1992) focus on the success of systems design as an "independent variable" and then try to identify the parameters set above. According to their examination of 190 articles in this area, they identified major variables that other researchers used as bases for their evaluation models. They started by using a model of evaluating a communication system that measures the quality of information as a result in the level of technical, semantic and effectiveness. Based on this study, researchers in an effort to extend this model, identified the other extended variables of system quality, use, user satisfaction and individual and organisational impact.

The above variables potentially affect the success of this healthcare ontological framework. This study's consistent set of concepts and designs should be evaluated from a specific evaluation framework based on the literature presented above. Thus according to Bodart et al. (2001), as a conceptual model describes "some aspects of the physical or social world around us for the purpose of understanding the complete representation of someone's perception of the semantics underscoring a domain it should be evaluated". This study's conceptual model approaches the world from the constructivist point of view based on ontology (see Figures 4.3 and 4.4). Thus, according to the adopted methodology steps (see Figure 4.6) the two enterprise ontology design methods of conceptual modelling (BB model) and ontology design (WB model) provide evidence for an ontology evaluation framework. An ontological framework should be consistent with the below Gruninger and Fox, (1995) methodology that fundamentally defines the nature of this study. It should also be consistent with solving the healthcare problem in the patient flow design and satisfy the decision-making process analyzing measures for quality flow. Finally, the CLIPS technology of the supporting information system that stores the OS ontological rules and implementation data is a valuable tool for this framework's design. Thus, the the role of this enterprise ontology framework evaluation is to evaluate the achieved model-driven enterprise design, analysis, redesign and implementation (see Figure 4.6). For the design and analysis part of this study, the following questions relative to the redesigning impact of this process should be examined (Fox and Grüninger, 1994):

- Is the process design in accordance with this study's aim for a patient-oriented, flow concept?
- Could we omit certain subject transactions or types of objects, so that the evaluated performance results could improve?

For example, if a policy for certain data-logical object class (type of object) is omitted at a certain ontological transaction, is the patient flow quality affected?

For the implementation part of this study, the OS should be able to represent the aim and objectives of this study. Thus, it must answer to questions relating to what has happened to patients that followed the contemporary situation, and what might happen for patients that will follow the proposed design. The OS should also supply information and knowledge necessary to support the implementation of the flow, whether performed manually or, in this study's case, by a machine through the supporting information system on CLIPS database.

Thus, this OS must be able to provide answers to questions usually asked in the performance of the model transactions. According to Campbell and Shapiro (1995), an ontological model “consists of a representational vocabulary with precise definitions of the meanings of the terms of this vocabulary plus a set of formal axioms that constrain the interpretation and well-formed use of these terms.” Bunge’s semiotic triangle and ontological parallelogram of this flow clearly define the concept’s implementation at which this study is aiming. Chapter ten with the conclusions of this study will deliver answers to the above questions in an effort to summarise all the conceptual differences between the two different patient flow designs. Enterprise ontology axioms will assist in this aim. Thus, how could someone evaluate that the implemented ontological approach serves this study’s aim and objectives? According to Gruber (1995) and Grüninger and Fox (1995), the criteria are the following:

1. Functional Completeness: Is the problem that this study aims to solve represented properly through the ontological structure and information necessary for a transaction to deliver result?

2. Generality: To what degree this ontological model could be shared between diverse transactions in different levels of the healthcare sector?

3. Efficiency: Is this ontological model in support of efficient reasoning? (e.g., is there enough evidence for the exact span of authority of each actor as well as for the transactions that the actor needs to perform?)

4. Perspicuity: Is the ontological model and its supporting system easily understood by the users so that it can be consistently applied and interpreted across the healthcare sector?

5. Precision/Granularity: Is there a core set of ontological processes that are hierarchically partitioned or do they overlap in their interpretations and results? Does the representation support reasoning at various levels of abstraction?

6. Minimalism: Does the ontology contain the minimum number of type objects necessary for the subjects to implement the concept of this study?

According to this competency concept, the model should be evaluated relative to the expressiveness of the ontology that is required to represent the aim and objectives of this study and to characterise its results (Fox and Grüninger 1994). Thus, the above evaluation framework will be useful for evaluating the ontological model of this study. According to Gruber's ontology definition (1993) presented in the introductory chapter of this study, this evaluation's study concepts and models should be understandable and natural, as ontology is considered a slice of reality. So, the POMR ontological model and its supporting information system should be applicable and qualitative in harmonic balance between generality and specificity, since, according to Gruber (1995), no ontological framework is ever complete.

8.4 OS Evaluation Study Description

The evaluation methodology is based on the ontological conceptual perspective as defined by Gruber (1993), and it is relative to the DeLone and McLean model for information systems evaluation as presented above. Thus, the evaluation study should include steps that are concerned with the functional completeness of the model: generality, efficiency, perspicuity, precision and minimality.

Therefore, this evaluation study will be concerned with this study's flow-process model expressed through the ontological parallelogram (Figure 6.2) and the DEMO designing tools of chapter five and six, which will be verified for their conceptuality and design. The evaluation study will also focus on the supporting information system of chapter seven that serves as a systems support tool for functional transparency of this novel, patient-oriented framework (OS). This OS primarily empowers the patient with access to valuable information and also serves as this study's functional evaluation of the concept through CLIPS technology in order to verify the rules' syntax, precision and efficiency. This evaluation study is assisted by the study's respondents and interviewees, and any corrections or improvements proposed by them as evaluators are taken into consideration before the framework's final review. Once the questionnaire parts were delivered, a brief discussion was initiated in relation to the questions of each part. During evaluation of the framework's efficiency, the criteria set according to the above competency framework and evaluation methodology of Grüninger and Fox (1995) was examined in order to asses the study's conceptual foundation and redesigning techniques. Then, a presentation of the OS with a group of evaluators evaluated the organisational need for this framework. The following diagram exhibits the system's evaluation steps:

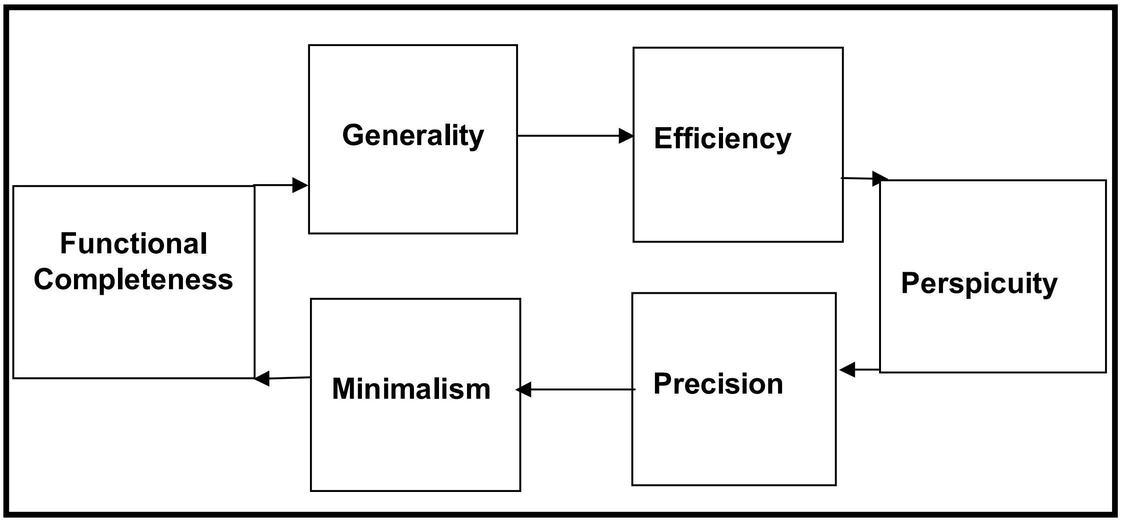


Figure 8.1: The OS Evaluation Path

8.4.1 The Functional Completeness

According to Friedman (2001), the evaluation approach must be considered in relation to the nature and the structure of the organisation. The BB perception of the model usefulness is directly dependent on its functional completeness (Dietz 1993). The research that was conducted in early stages of this study and presented in chapter three and five as well as the evidence provided in the literature review in chapter two has identified the need for this system to improve the quality flow of the patients according to the concept of this study. The functional completeness through the WB perception assures that the problems identified are addressed by this novel model. Given the measuring function at info-logical level of POMR application to the healthcare ontological model flow, the functional completeness will prove the need for this reengineering towards this novel system. Since the evaluation of the specific framework is prior to its future practical implementation, the functionality completeness of its development stage is justified (Sutton, 2000). The POMR framework evaluation for functional completeness focuses on the adopted methodology redesign, and the relevant questions for the OS actors are included in the actors' technical questionnaire.

8.4.1.1 Questionnaire

The aim of the questionnaire is to verify the validity of the redesign and an early actors' perception of the proposed framework (OS). The functional completeness part 1 of the questionnaire contains four questions. The first two relate to the evaluation of the degree of acceptance for the ontological design of the contemporary situation of the patient flow (US). The other two relate to the functional completeness of the novel framework (OS) and the direct relationship between its components: the model and its supporting information system. Due to the complexity of the framework, the questions range from 1-3 (agree-disagree), representing the level that the specific analysis of the current framework (US) is representing reality. The ideal score for this first part of the questionnaire is 3, indicating that the current framework (US) analysis is functionally complete, and there is a need for this reengineering towards a proposed one (US) that will contain a model and a supporting information system for its functional completeness. The evaluator actors' information is exhibited to the Table below:

NUMBER	POSITION	SPECIALTY	DEGREE
1	Doctor	Cardiology	MD
2	Doctor	Cardiology	MD
3	Doctor	Pathology	MD
4	Doctor	Pathology	MD
5	Doctor	Pathology	MD
6	Doctor	Microbiologist	MD
7	Doctor	Microbiologist	MD
8	Head Nurse		Bsc
9	Head Nurse		Bsc

Table 8.1: The Actor Involvement Respondent Information

8.4.1.2 Evaluators

In this entire questionnaire, the evaluators, who were domain experts that offered their valuable time in order to assist throughout the duration of this study, considered parts which are six (see figure 8.1). An appointment was arranged, and then they were exposed to all the parts of the questionnaire after a brief presentation which had two parts. The first part of the presentation was a brief enterprise ontology explanation (see appendix 4), and the second part of the presentation was the introduction of the actual POMR-framework disk software attached in appendix 5. Then, the questionnaire part 1 was explained to them, and then they filled in their responses.

8.4.1.3 Findings

The following Table represents the degree of agreement of evaluators for each of the questions included in part 1 of the questionnaire in relation to the framework's functional completeness.

Question	**% Agree 3**	**% Partly Agree 2**	**% Disagree 1**
Realistic US Process Division	100		
Realistic US Transaction Division	85	15	
OS functional completeness	100		
OS parts relationship (POMR /POM)	100		
Average Perceived Solution	**96.25**	**3.75**	

Table 8.2: The Actor Involvement Evaluation Statistics

8.4.1.4 Discussion of Findings

The high scores achieved regarding the question results provide evidence from the evaluators for functional completeness. There was a small debate among the respondents, which resulted in their agreement that the US analysis can not reach further than it did due to a lack of clinical procedures.

In addition, they all agreed that, based on this core US analysis, the functional completeness of the proposed framework with the model and its supporting information system are more than enough in order to start implementing a patient-oriented framework.

8.4.2 Generality

The generality of this restructured ontological model could be determined by evaluating whether the patient queries of the novel framework (OS) are reduced in relation to its contemporary structure (US). Generality will also evaluate the degree to which different actors' queries could be reduced as well due to this novel restructured flow (OS). Thus, this evaluation stage starts at the design phase and construction analysis step1 and step 2 of the adopted methodology in order to determine the necessary requirements at step 3 for the US redesign (see Figure 4.6). So the developer's perception of the current situation for all the framework's actors are captured through the two initial questionnaires, one for the patients, which is presented in chapter three, and one for the doctor's, which is presented in chapter five. The future actors were asked at this phase to answer an evaluation questionnaire after examining the POMRS framework (OS). The future actors were questioned in order to evaluate the parameters and rules of the POMR model and the relevant measures of the POMRS at info-logical and data-logical level. They were also required to fill out any comments regarding the OS redesign.

8.4.2.1 Questionnaire

The aim of the questionnaire is to verify the validity of the redesign and an early actors' perception of the proposed framework (OS). The generality part 2 of the questionnaire also contains four questions (see appendix 3). In this part of the questionnaire, the evaluators were asked to express their perceptions regarding how this ontological approach and specifically the redesigned novel framework (OS) assist in the communication improvement between patient and the healthcare stakeholders, minimising the amount of queries which are currently present in the US due to lack of such flow design. Each question is directly relevant to each sub-process of the OS and refers to the degree of the information which is supplied to the patients at each sub-process in order to make a flow decision. Thus, there is an evaluation requested concerning the level of proactive service that the “patient” is receiving, thus eliminating potential questions relevant to alternative flow paths.

8.4.2.2 Evaluators

In this entire questionnaire, the evaluators, who were domain experts that offered their valuable time in order to assist throughout the duration of this study, considered six parts (see Figure 8.1). The evaluators’ information is presented analytically in the following figure. The two nurses were not asked to respond in this part, as the generality as this part of the questionnaire is primarily relevant to the patient-doctor relationship.

NUMBER	POSITION	SPECIALTY	DEGREE
1	Doctor	Cardiology	MD
2	Doctor	Cardiology	MD
3	Doctor	Pathology	MD
4	Doctor	Pathology	MD
5	Doctor	Pathology	MD
6	Doctor	Microbiologist	MD
7	Doctor	Microbiologist	MD

Table 8.3: The Actor Involvement Respondent Information

8.4.2.3 Findings

Table 8.4 represents the degree of agreement of doctors that evaluated each of the questions included in part 2 of the questionnaire in relation to the framework’s functional completeness.

Question	% Agree 3	% Partly Agree 2	% Disagree 1
OS Sub-Process 1:Patient has enough information to decide	100		
OS Sub-Process 2:Patient has enough information to decide	85	15	
OS Sub-Process 3:Patient has enough information to decide	78	22	
OS Sub-Process 4:Patient has enough information to decide	100		
Average Perceived Solution	**90, 75**	**18.5**	

Table 8.4: The Actor Involvement Evaluation Statistics

8.4.2.4 Discussion of the Findings

During the usual discussion which followed each part of the questionnaire, the evaluators of this part discussed the model's generality. They agreed in principle that patients were receiving enough explicit information to make a logical choice, as the questionnaire results exhibit (see Table 8.4). They emphasised, however, that the doctor's tacit knowledge is a parameter which should always be considered when a patient makes a choice, especially during the referral and the treatment process. Thus, these processes do provide enough information, but tacit knowledge data storage in CLIPS is a valuable data-logical and info-logical tool of this framework at real implementation stage. So, yes the model is general enough, and due to the explicit information provided through the POMRS measures bridges a lot of communication gaps. It possesses, however, a valuable momentum relative to tacit knowledge stored in CLIPS. They also agreed that meta-data analysis of the information stored in CLIPS will provide valuable tacit knowledge for further study and development of this OS.

8.4.3 Efficiency

During this evaluation phase the model's efficiency is demonstrated. There is more than one way to represent the same knowledge, as is obvious from chapter five and six that the representation of the current US versus the novel OS does not have the same complexity when answering a specific set of questions. Furthermore, the deductive capability provided with the ontological structure of this study is directly affected by the CLIPS knowledge storage of the OS, versus the compute-as-we-go model of the contemporary US. The technical correctness relative to rules' syntax, reliability and ease of use of the POMRS supporting information system assures the OS efficiency. This deduction mechanism, expressed through COOL technology of CLIPS' conflict resolution strategy, is an advantage that assists this study's concept as, with its measurements, it could provide reports of tacit knowledge per transaction demand, delivering useful and efficient knowledge for best transaction results. By asking the evaluator actors if this system of reports assists in minimising the average POMR model complexity of the competency questions occurring per model's transaction, the evaluation criteria of efficiency will be satisfied.

8.4.3.1 Questionnaire

The efficiency part 3 of the questionnaire contains four questions (see appendix 3) regarding core efficiency gaps in the OS design.

8.4.3.2 Evaluators

There were nine evaluators as presented in the above Table (Table 8.1: The Actor Involvement Respondent Information).

8.4.3.3 Findings

The findings of this efficiency part 4 of the questionnaire are the following:

Question	% Agree 3	% Partly Agree 2	% Disagree 1
OS Sub-Process 1 has no obvious efficiency gaps	100		
OS Sub-Process 2 has no obvious efficiency gaps	100		
OS Sub-Process 3 has no obvious efficiency gap.	100		
OS Sub-Process 4 has no obvious efficiency gaps.	100		
Average Perceived Solution	**100**		

Table 8.5: The Actor Involvement Evaluation Statistics

8.4.3.4 Discussion of the Findings

On this part, the respondents agreed that the framework's efficiency is more than sufficient, if someone considers the situation today. They did, obviously, raise several political issues irrelevant to the focus of this study that the researcher had to limit in order to proceed to the next part of this evaluation methodology.

8.4.4 Perspicuity

The clear flow of this model is enhanced by its enterprise ontology axioms presented in chapter five and six, which guarantee user satisfaction through the OS transparent operation. The formal definitions of the state model expressed through the ontological parallelogram and semiotic triangle assist through the implementation of the WB model and this model's usefulness. On the other hand, as previously mentioned in the literature review chapter two, this usefulness is limited to the degree that correct and proper result interpretations of measurements and transactions are perceived according to the NHF of each country. Thus, whether the ontology is easily understood by the actors so that it can be consistently applied and interpreted across this novel framework, will be the objective of this evaluation phase and the evaluation questionnaire design.

8.4.4.1 Questionnaire

The perspicuity part 4 of the questionnaire contains four questions regarding the perspicuity of the novel POMR transactions and their supporting POMRS.

8.4.4.2 Evaluators

There were nine evaluators as presented in the above Table (Table 8.1)

8.4.4.3 Findings

Question	**% Agree**	**% Partly Agree**	**% Disagree**
	3	**2**	**1**
OS Sub-Process 1 role and action rules are clear	100		
OS Sub-Process 2 role and action rules are clear	100		
OS Sub-Process 3 role and action rules are clear	100 .		
OS Sub-Process 4 role and action rules are clear	100		
Average Perceived Solution	**100**		

Table 8.6: The Actor Involvement Evaluation Statistics

8.4.4.4 Discussion of the Findings

The findings exhibited in Table 8.5 underscore for this part 4 of the questionnaire that all of the evaluators agree that both the novel model transactions (POMR) and their supporting information system (POMRS) are comprehensible and clear at this core analysis level. They did, however, comment that at a further level of analysis this framework demands a lot of resources which should be provided for implementation of this concept.

8.4.5 Precision

During this evaluation phase, the precision of the ontological model was assessed relative to the degree of the definitions extendibility of the concepts. According to Sowa (1995), precision of ontology refers to what extent the definitions of concepts are distinct. Given that the formal definitions are determined, the transactions' hierarchy relative to the concepts' intersections should be examined. Granularity will serve to define the extent to which this ontological model is decomposed, based on the WB conceptual model, into necessary sub-processes, transactions and actions. The evaluation of the ontology precision will show that the US queries are minimised to the OS and thus aid user satisfaction through the system's sufficient implementation.

8.4.5.1 Questionnaire

The precision part 5 of the questionnaire contains two questions and requests from the evaluators that they characterise certain OS transactions as primitive in their nature. That means that they do not conceptually overlap with other OS transactions. In relation to the model's granularity, they were also requested to evaluate the structure of the proposed model by indicating transactions which hierarchically do not fit or are misplaced.

8.4.5.2 Evaluators

There were nine evaluators as presented in the above Table (Table 8.1)

8.4.5.3 Findings

The transactions due to the core analysis of this framework were characterised as primitives and hierarchically stable at the two first hierarchical levels of the action transaction diagram and the TRT Table as exhibited in appendix 3 of this study. Although no transactions were crossed out of this model there were certain comments.

8.4.5.4 Discussion of the Findings

The comments, which were indicated in this part of the questionnaire, were directly relevant to the tertiary transactions and their occurring results. The evaluators theoretically agreed that, at this level of analysis, they look correct, although it is most probable that they will vary in practice according to the second and first level transactional results.

8.4.6 Minimalism

Finally, in this evaluation phase the ontological model, minimalism is determined by proving that for every object class there is no other equivalent. In this phase, the info-logical and data-logical assistance of the supporting information system to this model transaction, minimalism will be examined. This last evaluation aids development of OS lean structure. Thus, the data-logical infrastructural minimalism will be evaluated by the framework's actors.

8.4.6.1 Questionnaire

The minimalism part 6 of the questionnaire contains four questions (see appendix 3) regarding the set of documents that are necessary for the patient-orientation concept to be implemented.

8.4.6.2 Evaluators

There were nine evaluators as presented in the above Table (Table 8.1)

8.4.6.3 Findings

They all agreed that, at this data-logical level (Object class) of analysis, these document classes are sufficient, and there is no need for others. They did, however, mention that, in practice, there must be close supervision, as in practice there is always the danger of a proliferation of minor documents which may relate to these object classes. On the other hand, eight of them, all of them doctors, crossed out two classes of documents. These classes are:

1. Verification Treatment Process Electronic Record of Methodology
2. Electronic Medical Operation Record

8.4.6.4 Discussion of the Findings

The discussion of this part was also relevant to their feelings regarding the above two document classes. They claimed that, although they understand the documentation relating to Verification Treatment Process Electronic Record of Methodology and Electronic Medical Operation Record, they do not find it to be correct. They also raised legal issues concerning those two object classes relative to privacy principles.

8.5 Summary and Conclusions

This chapter has proposed an evaluation method relative to the new approach study which was redesigned with the assistance of enterprise ontology. There were other relevant evaluation methods that were reviewed, but the one adopted is directly relevant to the nature and design of this study. Thus, as the evaluation is an integral part of most of the systems analysis and design methodologies, this framework's evaluation starts by verifying the ontological functional completeness of the framework. It also requested from the respondents that they evaluate the competence between the POMRS supporting information system and its POMR model's help at the ontological level of decision-making. In the second and third evaluation phase of the adopted methodology (see figure8.1), it was requested, first from the doctors and then from all the respondents, that they evaluate the process and the transactional proactive nature of the quality service and then that they asses the model's transactions (POMR) and their supporting information system (POMRS) in relation to their efficiency.

For the other four phases of this evaluation method, they were also asked to indicate the perspicuity and granularity of the framework's realisation as well as the transaction's primitive nature and hierarchy. Finally the object classes were evaluated for their level of minimalism.

The rationale behind Grüninger and Fox's (1995) evaluation methodology is to prove that the framework is worth being promoted as its usefulness is determined. The Dietz (2006) adopted methodology of this study has provided an alternative path towards the implementation of patient-oriented frameworks. This enterprise ontology path leaves no space for possible misunderstandings of this study's redesign regarding a national patient-oriented framework. As the above six evaluation parameters of the proposed methodology prove, the framework's new patient-orientation redesign, this OS could form the base for further research, recognising the pragmatic reasons for evaluation. Thus, after this evaluation chapter certain basic conclusions relative to this OS realisation and implementation can be drawn.

Chapter 9 Conclusions

9.1 Introduction

After the evaluation of the POMR framework, the objective of this chapter is to critically review all the conclusions introduced at each level of this study's organisation. It also revises the aim and the objectives of this study in a critical perspective, the hypotheses of the research and also the research problem and question of this national patient-flow framework (POMR), which is implemented based on the patient-oriented concept as presented, analysed, designed, redesigned and evaluated in this study.

9.2 Review of the Aim and Objectives of the Study

The aim of the study according to its title and as presented in chapter one and further analysed in chapter two is to conceptualise and implement a Patient-Oriented Management and Reporting (POMR) framework at national level. Its feasibility is demonstrated by the design of framework prototype (OS) at all organisational levels according to enterprise ontology methodology (DEMO). The objectives of this study were the redesign of a patient-oriented model and a supporting information system able to evaluate the concept's implementation. The objectives were also oriented towards measurable efficiency service levels and effectiveness not only at ontological level, transactional results but also at data-logical and info-logical level. The POMR model redesign (OS) provided a model at the ontological level that delivers results that conceptualise and implement the aim and the objectives of this study (the Patient-oriented concept) through a measurable transaction hierarchy. The Patient-Oriented Management and Reporting System (POMRS) was introduced to store the framework's documentation (object classes) at data-logical level and provide valuable performance reports at info-logical level. The OS implementation through CLIPS assists in the patient-oriented, holistic conceptualisation at ontological level. The POMRS also serves as a database, which, in addition to storing the framework's ontological transaction rules, documentation and relevant information, could potentially generate through meta-data in a certain time-horizon efficient patient flow designs. Thus, the aim and the objectives of this study, through the DEMO ontological redesign methodology and the CLIPS technology support, has been identified by the evaluators of this study as a major support for the improvement of the national patient-flow process.

9.3 Research Results

The research described in this study has delivered the following outcomes:

- The discovery of the gaps in the patient flow process
- The introduction of the enterprise ontology redesign methodology
- The design of a POMRS supporting information system
- The realisation of the Patient-oriented framework (OS)
- The implementation of the POMR framework with CLIPS

The above research results are discussed in turn below.

9.3.1 The Gaps in the Patient Flow Process

According to literature review in chapter two, similar concepts in other healthcare systems have been developed historically throughout the world, based on several systems approaches. According to Venix (1996), none of them introduces ontology, but rather qualitative and quantitative systems approaches which leave room for misconceptions. Other designs based on system dynamics approaches focus on the quantitative patient-flow analysis in order to develop national policy guidelines. According to Wolstenholme (1999), a model of total patient flow is presented for the UK NHS and a quantitative systems approach is applied based on system simulation methods. In addition to their different nature and aims of their studies, most of the recently-developed ontological systems result in conceptual gaps regarding this study’s holistic patient-oriented approach (Dietz 2006). Other studies mainly focus on optimal patient flow using quantitative system simulation or other healthcare-oriented approaches, both in the form of discrete entity approaches and in combination with the use of systems dynamics (Davies and Davies, 1986). According to chapter two, other approaches similar to this study’s conceptual domain primarily focussed on the procedural, quantifiable maximisation of the patient flow process and their performance assessment (Berwick et al., 2003). Despite their conceptual limitations, such studies were considered a valuable input for this paper's alternative orientation. Finally, as these studies were examining such flow without taking into consideration the dynamic nature of an ever-changing national healthcare environment and its interaction with novel model designs and the contemporary technological environment, this study's OS bridged that framework gap in a patient-oriented way.

9.3.2 Introduction of the Enterprise Ontology Redesign Methodology

The nature of the patient flow in the healthcare industry in relation to patient satisfaction and treatment raised the need for ontology. Enterprise ontology is a novel subject that mastered the complexity of this study's problem redesigning domain based on appropriate analysis, design and redesign methods and techniques (DEMO). It managed to master the concept of this framework in a coherent, comprehensive, consistent, concise, but most of all, essential way.

According to the study's literature review, such modern ontological frameworks provide a common understanding among the healthcare actors, who may very well understand each other but bear a different approach, culture, understanding and, most of all, comprehension of this study's concept implementation. Thus, a formal, explicit realisation of a shared conceptualisation and its core processes is served through the introduction of enterprise ontology.

9.3.3 The Design of a POMRS Supporting Information System

According to the Dietz (2006) methodology presented in chapter four and the organizational theorem, in order to realise the aim of this study, there was a need for the three organizational aspects of the framework (data-logical, info-logical and ontological). At the data-logical and info-logical level, documents (data inputs) and evaluation reports (data outputs) in a layered nesting method support this model's realisation by providing the necessary functional components (measurable objects) in order to assure the conceptualised flow of the model at the ontological level.

9.3.4 The Realisation of the Patient-oriented Framework (OS)

The realisation of this OS redesign, which includes a model and a supporting information system, is produced in chapter six of this study after the analysis and design of the US in chapter five. That is why the POMRS is clearly distinguished from the POMR model, as it is realised as a work-flow system that supports the coordination acts of the POMR model. Thus, according to chapter six, the framework's actors have the ability to produce ontological acts based on the POMR model (performa acts) when they have the necessary info-logical support (informa acts) of the POMRS. Thus, the concept realisation of this framework is behind every transactional measurable result of the model with the support of the POMRS performance measures. The degree of the systems implementation in chapter seven could be potentially measured by evaluating the framework's conceptualisation level, which is the patient-oriented, service level. Finally, the necessary documentation and results as well as the decision performed at the ontological level should be stored through its implementation with the CLIPS technology.

9.3.5 The Implementation of the POMR Framework with CLIPS

In chapter seven, the necessary infrastructure for the POMRS, supporting information system is introduced. The data-logical acts or D-applications are running the function with CLIPS technology of the POMRS, which is support for the top ontological level. The POMRS supporting information system is directly linked in the same chapter with the model's transactions and transaction results. Thus, the data-logical organizational level of CLIPS implements the production acts which are becoming facts by being realised at the other two framework levels (info-logical and ontological). Finally, according to chapter seven, the Implementation of the POMR framework in CLIPS delivers the production acts of storing and document transporting based on the knowledge-base action rules of the model's transactions bridging all realisation and implementation gaps of the existing methodologies.

9.4 POMR Framework (OS) Results

To conclude, the research results and their evaluation in chapter eight underscore the need for this study's framework design. On the other hand, the research results lead to certain practical conclusions in a future framework operation. All the above OS level dependences form a transaction pattern where the T01 transaction initiates patient relationship management with the request of a healthy entity to become a healthcare flow-process subject. Specifically, the primary transactions of T02 to T06 will evaluate the patient-oriented collection of measures' results, which are directly relevant to the mission and objectives of this study, due to the downward nature of their value-chain model presented in the literature review chapter. The final result, which is patient satisfaction and treatment of the whole patient-oriented flow will occur at either transaction T05 or T06, depending if further rehabilitation is necessary or not. The T01 result, according to the above chart, is patient relationship management that is present with acts that become facts. Based on the results proposed, a performance measurement scorecard evaluates the patient orientation of these flow acts. This final core transaction, T06 or T05, allows T01 to be triggered again, so the treated patient could continue receiving proactive, treatment–relationship management information through the national healthcare line centre after exiting this flow. This exact function of all of the above transactions is analysed in the OS and implemented with CLIPS technology.

Finally, this chapter concludes by summarising in a table all the major design results, per sub process of the patient flow, between the contemporary flow framework (US) and the novel flow framework proposed (OS).Thus, table 9.1 exhibits clearly all the redesign benefits which result from this study's proposed patient-oriented flow.

MAJOR US RESULTS	MAJOR OS RESULTS
US P01: Patient Appointment to GP • Call centre serves as a multiple point of patient interaction • Patient flow performance appraisal not directly linked to appointment results • There is no tracking for GP appointment cancellation • Long, not measurable waiting lines for GP appointment • Ineffective GP appointments	OS P01: Patient-Oriented Inflow • Call centre serves as a single point of patient interaction • Patient flow performance directly linked to appointment results • Continuous measurable guiding to patient for GP appointment • Short and measurable waiting lines for GP appointments • Effective GP Appointments
US P02: Patient Referral • System loops require multiple GP appointments • Call centre could not follow process • Ineffective GP appointment that result to lack of diagnosis • Emphasis partly placed on GP appointment time schedule	OS P02: Patient Referral Treatment • No system loops enhance patient flow • Call centre monitor and measures process • Effective GP appointments lead to diagnosis • Emphasis placed on GP's diagnosis
US P03: Contemporary Treatment • Lack of traceable hospital inflow process • Doctor-oriented hospital inflow process • Lack of patient awareness for inflow process decisions • Haphazard inflow processes	OS P03: Redesigned Treatment • Traceable and measurable hospital inflow process • Patient-oriented hospital inflow process • Patient empowerment for hospital inflow decision making • Clear inflow process
US P04: Patient Discharge • Patient lacks treatment process awareness • Patient lacks information relating to medical performance • Lagging measures for patient rehabilitation • Focus on patient transaction management	OS P04: Patient-Oriented Outflow • Patient awareness of full treatment cycle • Patient awareness of medical performance • Leading measures for patient rehabilitation • Focus on patient relation management

Table 9.1 Major Design Result Differences between US and OS (POMR Framework)

Chapter 10 Further Studies

10.1 Introduction

The objective of this last chapter is to propose further research studies beyond the conclusions introduced in the previous chapter. The research conducted for the scope of this study, as identified by the aim and the objectives of the study, has revealed several opportunities to take the organisation of this research to the next level.

10.2 Opportunities for Further Studies

The concept of this study was to approach and measure, in a patient-oriented way, using novel knowledge available in the field (e.g., Ontology) in order to minimise the misconceptions relevant to the problem domain of this study in a perspicuous way. There are, however, several opportunities for further research in the areas exhibited below:

10.2.1 Further Association of the POMR Framework with the NHF

A potential study on POMR and its interrelation with the NHF system will further improve the conceptual realisation of this study. Thus, concepts like patient relation rather than patient transaction could be further improved with the NHF assistance. According to this OS, the patient relation focuses on the patient satisfaction-level accumulated through results of measurable transactions within a healthcare environment that is implemented through this patient-oriented flow.

10.2.2 Elaboration of the Patient Decisions Empowered by POMRS

This framework's POMRS performance reports focus primarily on patient informational needs and assist all model actions from there. If further realisation of the above two frameworks (POMR and NHF) are studied, then the POMRS supporting information system could deliver many more measurable reports, as the two system's interdependence could turn this ontological model into a complete structure

10.2.3 Activity-Based Financial Efficiency

Cost is directly related to patient needs and expectations of a service well perceived. Due to the unique nature of this OS design, the measures proposed are linked to ontological transaction steps and thus subject to the medical insurance evaluation in relation to the consumer's medical insurance contract. Establishing thresholds or cohesive quality standards for each ontological step of this OS relating to each patient condition profile type could qualitatively minimise the patient-oriented flow cost.

10.2.4 Activity-Based Costing

This enterprise ontology OS framework is redesigned on activity-based transactions, as the patient flows through the healthcare system requiring value-added services that are present in the ontological model produced. Associating the relevant transactional costs to the model design could generate a "money for value" healthcare system.

10.2.5 Time Efficiency

As time equals cost, further time studies are relevant to optimal patient flow using quantitative system simulation, but this time based on a patient-oriented framework, will further improve the time efficiency of this OS redesign.

10.2.6 Accreditation Measures and Benchmarking Practices

In the future, international accreditation committees could encompass this study's framework to ensure safe, patient-oriented flow for their members. Ontology as a global scientific method assists in the production of new international measurements and benchmarks. Such measurements could be feasible beyond mere safety issues due to ontology's epistemology.

10.2.7 A Human Centred Information Environment

A fully–integrated, supporting systems design is redundant as it bypasses the ontological potential for possible customisations necessary in order to maximise the value of this study's concept. A human-centred environment focuses on providing room for such initiatives. The design of the POMRS focuses on the necessary measurements information that the patient needs in order to make a decision. The relation of subjective and objective world of ontology to these measurements of the POMRS as well as their interaction could further ensure a human-centred environment based on this study's framework redesign.

10.2.8 Safe and Fair CPGs and Clinical Governance

Cohesive clinical guidelines will lead to efficient and safe clinical governance. Based on its novel ontological approach and its measurable supporting information system, this OS could generate patient-oriented clinical governance as the kernel of this system is directly related to hospitals' transactions.

10.3 Summary

The summary of this study's contributions includes:

1. The discovery of the gaps in the patient-flow process relating to both the conceptual gap of patient-oriented definition and the design gap due to lack of ontology
2. The introduction of the enterprise ontology, redesign methodology as a proposed ontology methodology in order to bridge the contemporary situation's structural and conceptual gaps
3. The design of a POMRS supporting information system that could evaluate the level of the patient-orientation of the framework thus providing a useful tool for a country's NHF
4. The realisation of the Patient-oriented framework (OS), which includes three interdependent elements: an IT infrastructure, an information supporting system and an ontological model
5. The implementation of the POMR framework with CLIPS which could, in future, assist valuable, knowledge-base management for further development of the OS.

Appendix 1: Knowledge Base: Ontological Model Rules

PROCESS 01 Rules.
Actor CA01: Patient
On requested T01 (P=patient condition) appointment (new P=new patient condition)
AGENDA
ACTIONS
If <insurance status document> (IS) and < EPR> (R=Record) complete
then promise T01
If not <insurance status document> (IS=Insurance Status) complete
then decline T01
fi
no

<insurance status>
- ✦ Updated yearly insurance examination booklet
- ✦ No outstanding insurance payments

<EPR>
- ✦ All relevant to appointment exams completed according to <bill of examination>
- ✦ Prior <Patient condition> complete

On promised T01
If <appointment date requested available>
and if not <further exams> requested (P)
accept T01 (P)
execute T01(P)
fi
no
On accepted T01 (P)
If <examination referral> exists execute (P) T15 and T16
Then execute T01
fi
no

Actor CA02: Secretary/Call Centre
On promised T01 (P)
Do for all (P) appointment date execute T07
If stated T07 and< bill of examinations> complete then request T02
If not stated T07 then reject T01
If
do
no
On requested T02
On accepted T02 (R)
execute T01
state T01

no
<Bill of Examinations>
✦ Updated yearly all prerequisite examinations for medical conditions

Actor CA03: GP
On promised T02
execute T02 then request T15 and T16
no
On executed T15 and T16
execute T08 then state T08

no
Actor CA04: Medical Experts
On requested T15 and T16
execute <safe> T15 and T16

PROCESS 02 Rules
Actor CA03: GP
On requested T09 (P) with GP new patient (P) = DP= Diagnosed Patient
If not < patient condition with appointment date> then decline T09 (P)
Or <patient condition with appointment date> then promise T09 (P)
fi
no

On promised T09 (P)
execute T09 (P)
If not <patient condition complete with clinical or laboratory results > then execute T15 (P) and/or T16 (P)
Or <patient condition not accepTable by GP>
execute T14 (P)
state T09 (DP)
fi
no

On stated (DP)
execute T10 (DP)
state T10 (DP) with <POMR3>
no

On executed T03 (DP)
State T03 (DP) with <treatment referral> and <POMR2>
no
Actor CA01: Patient

On stated T10 (DP) with <POMR3 >
If accepted T10 (DP)
accept T09
request T03
If not accepted T10 with <POMR3>
then reject T10

fi
no
On stated T03 (DP)
Accept T03
No

PROCESS 03 Rules
Actor CA01: Patient

On accepted T03 (DP) with <treatment referral>
request T04
no
On requested T04 (DP) with <treatment referral>
Then Promise T04 (DP)
no
On promised T04 (DP)
If <Room> and <inflow process awareness> present
accept T04 (OP)
fi
no
On Stated T11(OP)
If <POMR communication record> exists
Accept T11 (OP)
Fi
No
On stated T17 (TP)
Accept T17 and T18 (TP)
No

Actor CA04: Clinical Personnel
On promised T04 (DP)
Execute T04 (DP)
no
On executed T04 (OP=Operation Ready Patient Condition)
If <room> and <inflow process awareness> available
Then
State T04 (OP)
fi
no
On accepted T11 (OP)
Execute T12
No
On executed T12 (OP)
If <electronic verification of treatment process> exists
Then State T12 (OP)
fi
No
On accepted T12 (OP)
Promise T18 (OP)
No

Actor CA05 Medical Experts
On accepted T04
execute T11 (OP)
no

On executed T11(OP)
if <POMR communication record> exists
state T11(OP)
fi
no
On executed T18 (OP)
If <electronic record of methodology>
State T18 (OP)
Fi
No
On executed T17 (OP)
If < electronic medical operation record> exists
State T17 (TP=treated patient)

PROCESS 04 Rules

Actor CA05: Medical Experts

On accepted T18 (TP)
Request T05 (TP)
No
Actor CA04 Clinical Personnel
On requested T05 (TP)
If <hospital discharge documents> exist
Then promise T05 (TP)
Execute T05 (TP)
Fi
No
Actor CA01: Patient

On Stated T05 (TP)
If <hospital rehabilitation procedures report> and < hospital discharge documents> exist
Accept T05 (TP)
On accepted T05 (TP)
Execute T13 (TP)
no
On accepted T13
Request T06 (TP)
No
On stated T06 (TP)
If <customised patient condition rehabilitation program> and <POMR1>and <POMR4> exists
Accept T06
no

Actor CA06: Rehabilitation Personnel
On accepted T05 (TP)
if <generic patient condition rehabilitation program> exists
then execute T13 (TP)
State T13 (TP)
Fi
No
On requested T06 (TP)
If <customised patient condition rehabilitation program> and < POMR1 comparable version> exists
Then state T06 (TP)
execute T06 (TP)
Fi
no

Actor CA01:Secretary/call centre

On executed T06 (TP)
Provide< POMR4>
State T06
On

Appendix 2: Patient Questionnaire Data

Πλήθος από Public/Private		
Public/Private	Άθροισμα	Άθροισμα
Public	32	61.54%
Private	20	38.46%
Γενικό Άθροισμα	52	100.00%

Πλήθος από Name of Hospital		
Name of Hospital	Άθροισμα	Άθροισμα
424 ΓΣΝ	6	11.54%
ΑΓΙΟΣ ΛΟΥΚΑΣ	8	15.38%
ΑΓΙΟΣ ΠΑΥΛΟΣ	2	3.85%
ΑΧΕΠΑ	11	21.15%
ΓΕΝΙΚΗ ΚΛΙΝΙΚΗ	7	13.46%
ΔΙΑΒΑΛΚΑΝΙΚΟ	5	9.62%
ΠΑΠΑΓΕΩΡΓΙΟΥ	7	13.46%
ΠΑΠΑΝΙΚΟΛΑΟΥ	6	11.54%
Γενικό Άθροισμα	52	100.00%

Πλήθος από Name of Hospital	Public/Private		
Name of Hospital	Public	Private	Γενικό Άθροισμα
424 ΓΣΝ	6		6
ΑΓΙΟΣ ΛΟΥΚΑΣ		8	8
ΑΓΙΟΣ ΠΑΥΛΟΣ	2		2
ΑΧΕΠΑ	11		11
ΓΕΝΙΚΗ ΚΛΙΝΙΚΗ		7	7
ΔΙΑΒΑΛΚΑΝΙΚΟ		5	5
ΠΑΠΑΓΕΩΡΓΙΟΥ	7		7
ΠΑΠΑΝΙΚΟΛΑΟΥ	6		6
Γενικό Άθροισμα	32	20	52

Appendix 2

Πλήθος από Q1	
Q1	Άθροισμα
1	7.69%
2	32.69%
3	42.31%
4	15.38%
5	1.92%
Γενικό Άθροισμα	100.00%

Πλήθος από Q2	
Q2	Άθροισμα
2	23.08%
3	57.69%
4	17.31%
5	1.92%
Γενικό Άθροισμα	100.00%

Πλήθος από Q3	
Q3	Άθροισμα
1	5.77%
2	32.69%
3	42.31%
4	17.31%
5	1.92%
Γενικό Άθροισμα	100.00%

Πλήθος από Q4	
Q4	Άθροισμα
1	1.92%
2	23.08%
3	57.69%
4	15.38%
5	1.92%
Γενικό Άθροισμα	100.00%

Πλήθος από Q5	
Q5	Άθροισμα
1	80.77%
2	19.23%
Γενικό Άθροισμα	100.00%

Πλήθος από Q6	
Q6	Άθροισμα
2	13.46%
3	59.62%
4	23.08%
5	3.85%
Γενικό Άθροισμα	100.00%

Πλήθος από Q7	
Q7	Άθροισμα
2	25.00%
3	44.23%
4	26.92%
5	3.85%
Γενικό Άθροισμα	100.00%

Πλήθος από Q1	Public/Private		
Q1	Public	private	Γενικό Άθροισμα
1	0.00%	7.69%	7.69%
2	7.69%	25.00%	32.69%
3	36.54%	5.77%	42.31%
4	15.38%	0.00%	15.38%
5	1.92%	0.00%	1.92%
Γενικό Άθροισμα	61.54%	38.46%	100.00%

Πλήθος από Q3	Public/Private		
Q3	1	2	Γενικό Άθροισμα
1	0.00%	5.77%	5.77%
2	11.54%	21.15%	32.69%
3	32.69%	9.62%	42.31%
4	15.38%	1.92%	17.31%
5	1.92%	0.00%	1.92%
Γενικό Άθροισμα	61.54%	38.46%	100.00%

Appendix 2

Πλήθος από Q6	Public/Private		
Q6	1	2	Γενικό Άθροισμα
2	1.92%	11.54%	13.46%
3	34.62%	25.00%	59.62%
4	21.15%	1.92%	23.08%
5	3.85%	0.00%	3.85%
Γενικό Άθροισμα	61.54%	38.46%	100.00%

Πλήθος από Q5	Public/Private		
Q5	1	2	Γενικό Άθροισμα
1	42.31%	38.46%	80.77%
2	19.23%	0.00%	19.23%
Γενικό Άθροισμα	61.54%	38.46%	100.00%

Records	**Name of Hospital**	**Public/Private**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**		**Public/Private**	**Q5**
1	424 ΓΣΝ	1	3	3	3	3	2	4	4		1	2
2	ΓΕΝΙΚΗ ΚΛΙΝΙΚΗ	2	2	3	2	3	1	3	2		2	1
3	ΠΑΠΑΝΙΚΟΛΑΟΥ	1	2	2	2	2	1	3	2		1	1
4	ΠΑΠΑΓΕΩΡΓΙΟΥ	1	2	2	2	2	1	3	3		1	1
5	ΓΕΝΙΚΗ ΚΛΙΝΙΚΗ	2	3	3	1	3	1	2	2		2	1
6	ΠΑΠΑΓΕΩΡΓΙΟΥ	1	4	4	4	4	2	3	3		1	2
7	424 ΓΣΝ	1	2	2	2	2	1	3	2		1	1
8	ΓΕΝΙΚΗ ΚΛΙΝΙΚΗ	2	2	3	3	3	1	3	3		2	1
9	ΓΕΝΙΚΗ ΚΛΙΝΙΚΗ	2	2	2	2	3	1	3	3		2	1
10	ΑΓΙΟΣ ΛΟΥΚΑΣ	2	2	4	4	3	1	4	3		2	1
11	424 ΓΣΝ	1	3	3	4	4	2	4	4		1	2
12	ΑΓΙΟΣ ΛΟΥΚΑΣ	2	2	3	2	3	1	3	3		2	1
13	ΑΓΙΟΣ ΛΟΥΚΑΣ	2	2	3	3	3	1	3	3		2	1
14	ΔΙΑΒΑΛΚΑΝΙΚΟ	2	1	2	3	3	1	3	2		2	1
15	ΑΓΙΟΣ ΛΟΥΚΑΣ	2	2	3	3	2	1	3	3		2	1
16	ΠΑΠΑΝΙΚΟΛΑΟΥ	1	3	3	3	3	1	3	4		1	1
17	ΔΙΑΒΑΛΚΑΝΙΚΟ	2	1	2	2	1	1	3	3		2	1
18	ΑΧΕΠΑ	1	3	3	3	3	1	4	4		1	1
19	ΓΕΝΙΚΗ ΚΛΙΝΙΚΗ	2	2	2	2	2	1	2	2		2	1
20	ΑΓΙΟΣ ΛΟΥΚΑΣ	2	3	4	1	3	1	3	3		2	1
21	424 ΓΣΝ	1	4	3	4	4	1	4	5		1	1
22	ΠΑΠΑΓΕΩΡΓΙΟΥ	1	3	2	3	2	2	3	3		1	2

Records	Name of Hospital	Public/Private	Q1	Q2	Q3	Q4	Q5	Q6	Q7		Public/Private	Q5
23	ΠΑΠΑΓΕΩΡΓΙΟΥ	1	3	2	4	2	2	3	4		1	2
24	ΔΙΑΒΑΛΚΑΝΙΚΟ	2	3	3	1	3	1	2	2		2	1
25	424 ΓΣΝ	1	2	2	4	3	1	4	3		1	1
26	424 ΓΣΝ	1	5	5	5	5	2	3	5		1	2
27	ΑΓΙΟΣ ΠΑΥΛΟΣ	1	4	4	3	4	1	4	4		1	1
28	ΠΑΠΑΝΙΚΟΛΑΟΥ	1	4	4	2	3	1	3	3		1	1
29	ΑΓΙΟΣ ΛΟΥΚΑΣ	2	1	3	2	3	1	2	3		2	1
30	ΑΧΕΠΑ	1	3	3	2	3	2	3	4		1	2
31	ΔΙΑΒΑΛΚΑΝΙΚΟ	2	1	2	2	3	1	3	2		2	1
32	ΑΧΕΠΑ	1	3	3	3	3	2	3	3		1	2
33	ΠΑΠΑΝΙΚΟΛΑΟΥ	1	3	3	3	2	1	4	3		1	1
34	ΓΕΝΙΚΗ ΚΛΙΝΙΚΗ	2	2	3	2	2	1	3	2		2	1
35	ΑΓΙΟΣ ΠΑΥΛΟΣ	1	4	4	3	3	1	5	3		1	1
36	ΑΧΕΠΑ	1	3	3	3	4	1	5	4		1	1
37	ΑΧΕΠΑ	1	3	3	3	3	1	4	4		1	1
38	ΑΧΕΠΑ	1	3	3	3	3	1	3	3		1	1
39	ΑΓΙΟΣ ΛΟΥΚΑΣ	2	2	3	2	2	1	2	2		2	1
40	ΠΑΠΑΝΙΚΟΛΑΟΥ	1	3	3	3	3	1	3	4		1	1
41	ΓΕΝΙΚΗ ΚΛΙΝΙΚΗ	2	2	3	3	2	1	3	3		2	1
42	ΠΑΠΑΓΕΩΡΓΙΟΥ	1	3	3	3	3	1	4	4		1	1
43	ΑΧΕΠΑ	1	4	4	4	4	1	4	4		1	1
44	ΔΙΑΒΑΛΚΑΝΙΚΟ	2	2	2	2	2	1	2	2		2	1
45	ΑΓΙΟΣ ΛΟΥΚΑΣ	2	2	3	2	4	1	3	2		2	1
46	ΠΑΠΑΓΕΩΡΓΙΟΥ	1	3	3	3	3	2	3	3		1	2
47	ΑΧΕΠΑ	1	4	4	4	3	2	4	4		1	2
48	ΑΧΕΠΑ	1	4	4	4	4	1	3	4		1	1
49	ΠΑΠΑΝΙΚΟΛΑΟΥ	1	3	3	3	3	1	3	3		1	1
50	ΑΧΕΠΑ	1	3	3	2	3	1	3	3		1	1
51	ΠΑΠΑΓΕΩΡΓΙΟΥ	1	3	3	3	3	1	3	2		1	1
52	ΑΧΕΠΑ	1	3	3	3	3	1	2	3		1	1

Appendix 2

Question 8 "*Do you have any complaints? If yes, please write them down.*"

Questionnaire	Comment
1.	High costs, low quality services
2.	The costs are relatively high compared to the quality of the services offered. The process of booking a room was very bureaucratic. Human factor is not taken into consideration at all. What I didn't like at all was the fact that the hospital is not flexible; they offer only special child-birth packages (eg 4 days or 6 days stay) and if you need to stay less days you are obliged to pay the whole package.
5.	Services offered are disproportional to the money requested.
6.	Too expensive
8.	High costs
10.	Long waiting lines
11.	There is lack of organization
13.	High costs for services
15.	Time wasted in waiting lines
16.	Quality of services is very low. Difficult procedure to get the money from insurance companies.
18.	Too much delay in everything
20.	Nurses were unwilling to hear your problem and almost unwilling to help.
21.	There is apathy towards the patients
22.	Lack of organization
23.	There is lack of communication among doctors and personnel.
24.	Very expensive services.
25.	Doctors did not explain the situation of the patient and gave incomplete information as far as the medicine is concerned

26.	Nurses were very rude and not helpful at all. In emergency rooms they put people in serious condition together with people that are not in so serious. Everything is messy.
27.	Rude nurses, lack of organization, too much noise
28.	High costs for the services offered.
29.	I was lucky because I had private insurance.
31.	High costs for the services offered.
32.	High costs for the services offered.
33.	I wanted a single room and that is why I had to wait for a very long time. The service is not good at all.
34.	Lack of service and information
35.	I felt that the information that I was given from the doctors was not reliable.
37.	The response of the nurses to my needs was very slow.

Appendix 3: Doctor Questionnaire

PART A THE PATIENT FLOW PROCESS

Is there a specific computerised module governing the healthcare organisation patient flow structure?

- Yes Please describe:
- No

Is there any kind of manual that analyses the patient flow structure in your healthcare organisation?

- Yes. Please describe:
- No

Is there a specific computerised module for evaluating the quality of the services provided by your healthcare organisation?

- Yes. Please describe:
- No

Is there any kind of quality manual relevant to the evaluation of the quality of the services provided by your healthcare organisation?

- Yes. Please describe:
- No

Do you have patient complaints regarding their quality level of the healthcare organisation service?

- Yes often
- Yes rarely
- No

Please specify if there are related to any of the following areas:

- Bed availability
- Room availability
- Specific Doctor Availability
- Treatment process
- Service process
- Patient Safety

PART B COMPUTING SKILLS

Do you know how to use a computer?

- Yes
- No

Do you have any knowledge of using a DSS?

- Yes Please describe:
- No

Are you familiar with the ERP systems?

- Yes Please describe:
- No

Are you familiar with any implemented performance measures in any Greek hospital?

- ✦ Yes Please describe:
- ✦ No

Have you ever calculated the cost of the patient flow structure based on patient actions occurred?

- ✦ Yes Please describe:
- ✦ No

If yes please explain how?

Are you familiar with the concept of ontology?

- ✦ Yes Please describe:
- ✦ No

How important is patient satisfaction in your healthcare organisation?

- ✦ Very important
- ✦ Important
- ✦ Not important

How important is patient treatment in your healthcare organisation?

- ✦ Very important
- ✦ Important
- ✦ Not important

PART C DEMOGRAPHICS

Hospital resource capacity (# beds)

- ✦ More than 1000
- ✦ Between 1000-700
- ✦ Between 700-500
- ✦ Between 500-200
- ✦ Less than 200

Hospital resource capacity (# Medical Doctors)

- ✦ More than 200
- ✦ Between 100-200
- ✦ Less than 100

1. Private sector
2. Public Sector

APPLIED REENGINEERING DEMO METHODOLOGY & CHANGE MANAGEMENT

ENTERPISE ONTOLOGY AND ERP

DEMO & BPR 2010,
PAPAGIANNIS AKIS

What is ontology? Aristotelian “on” something that exists

• As a branch of philosophy, ontology investigates and explains thenature and essential properties and relations of all beings, as such, or the principles and causes of being.

• As a modern concept in Computer Science (Artificial Intelligence), an ontology is a formal and explicit specification of a shared conceptualisation among a community of people (ánd agents) of a common area of interest.

What is enterprise ontology?

• The ontology (or ontological model) of an enterprise is defined as an understanding of its operation, that is completely independent of the realization and the implementation of the enterprise.

Enterpise ontology solves issues relevant to:

- Business process workflow
- Managing Information Systems
- Enterprise Resources Planning Systems
- IT infrastructure
- Internal control and staffing
- Quality Control

What is a system?

- A system is a set of elements that are related to each other.
- The distinctive difference between system and aggregate is that a system has emergent behaviour.
- Like any kind of things, a system is defined by its properties. An important property of a system is the category to which it belongs (physical, mechanical etc.).Itis either Homogenious or Heterogenious

The Teleological and Ontological System concept

TELEOLOGICAL SYSTEM

- Is about the function and behavior of a system
- Reflects the purpose of a system
- Is the dominant system concept in both the natural and the social sciences
- Is perfectly adequate for using and controlling systems (Black Box Model)

ONTOLOGICAL SYSTEM

- Is about the construction and operation of a system
- Is indifferent to the purpose of a system
- Is the dominant system concept in the engineering sciences
- Is perfectly adequate for building and changing systems (White Box Model)

Model Definition

Any subject using a system A that is neither directly nor indirectly interacting with a system B, to obtain information about the system B, is using A as a model of B. Leo Apostel (1960)

A thing is a system if and only if it has the next properties:

- **Composition**: a set of elements of some category (physical, chemical).A car, consisting of a physical system, a chemical system, an electrical system etc..
- **Environment**: a set of elements of the same category
- **Effect**: the elements in the composition produce things (products or services) that are delivered to the elements in the environment
- **Structure**: a set of influence bonds among the elements in the composition and between these and the elements in the environment

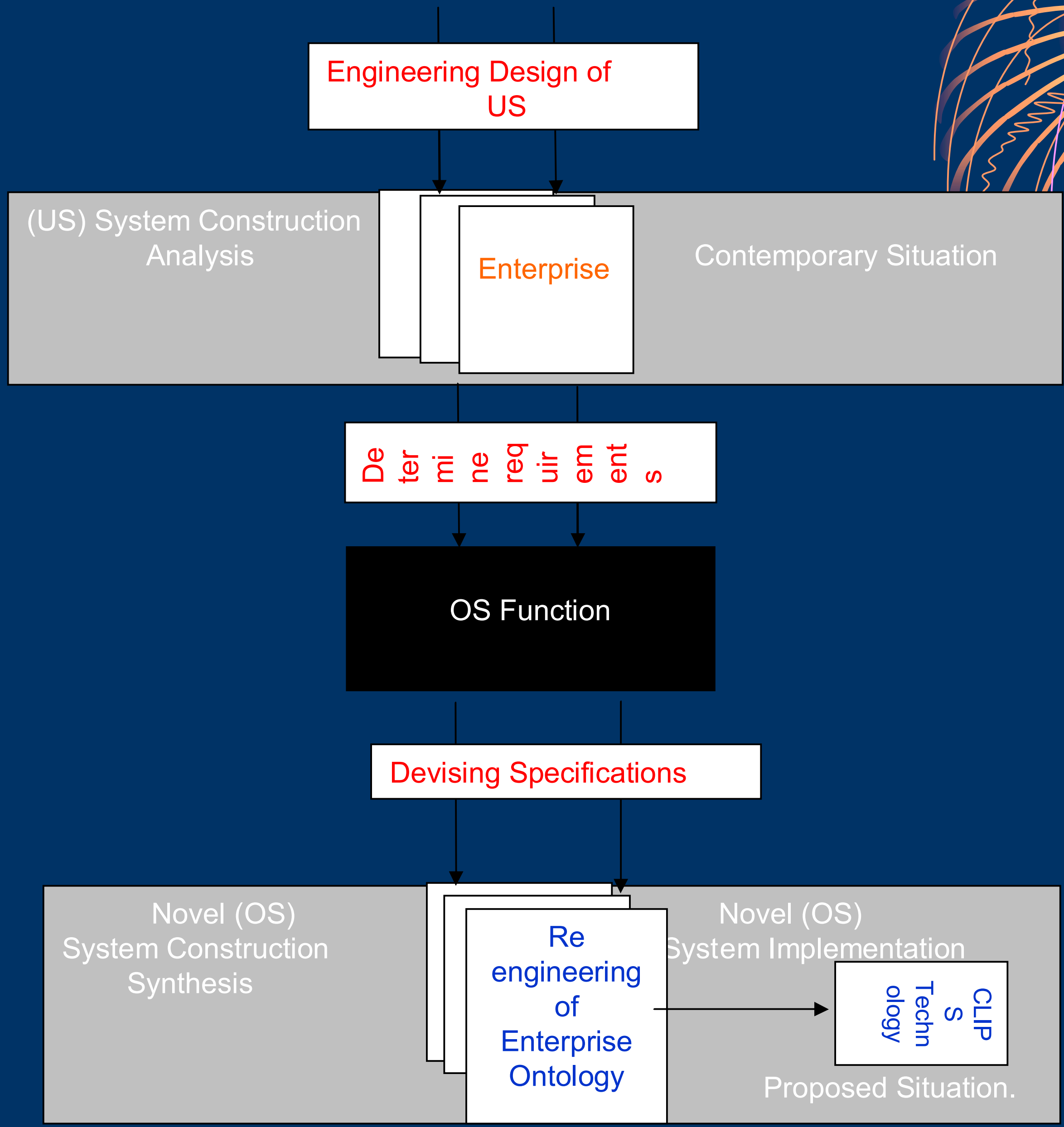
The WB & BB Model (e.g.Car) Constructional decomposition

- A WB model is a (direct) conceptualization of a concrete System, it shows the constructional behavior of a system.

  E.g. A model of the atom. WB model for a car: chassis, wheels, motor, lamps, (mechanic's perspective thus constructional decomposition)

- A BB model is a conversion of a WB model.
- BB model for a Car: steering system, power system, electrical system (the driver's perspective thus functional dicomposition) So, BB shows functional behavior of a system. (E.g. An balanced score card model of an enterprise).

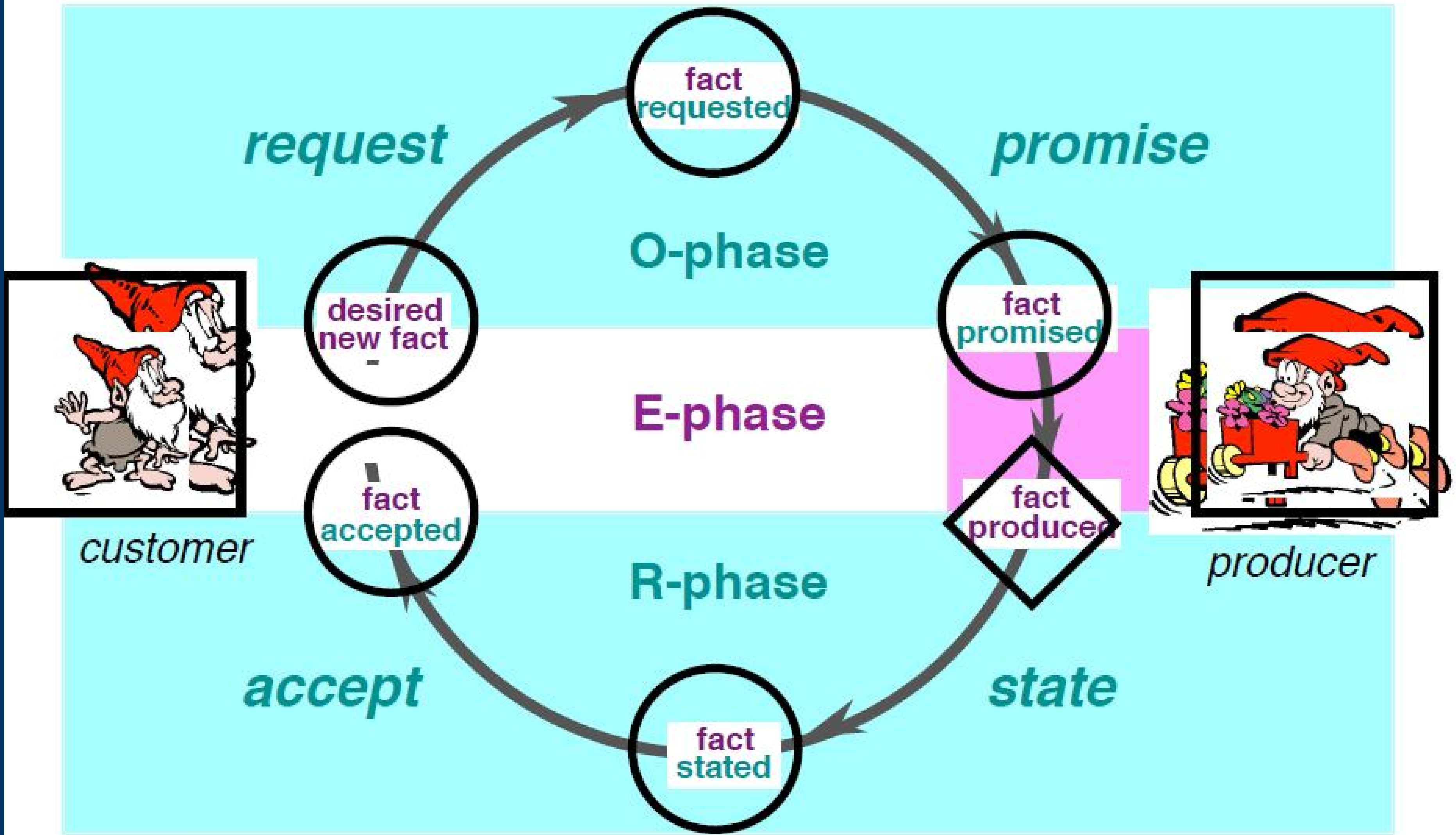
Reengineering with Ontologies



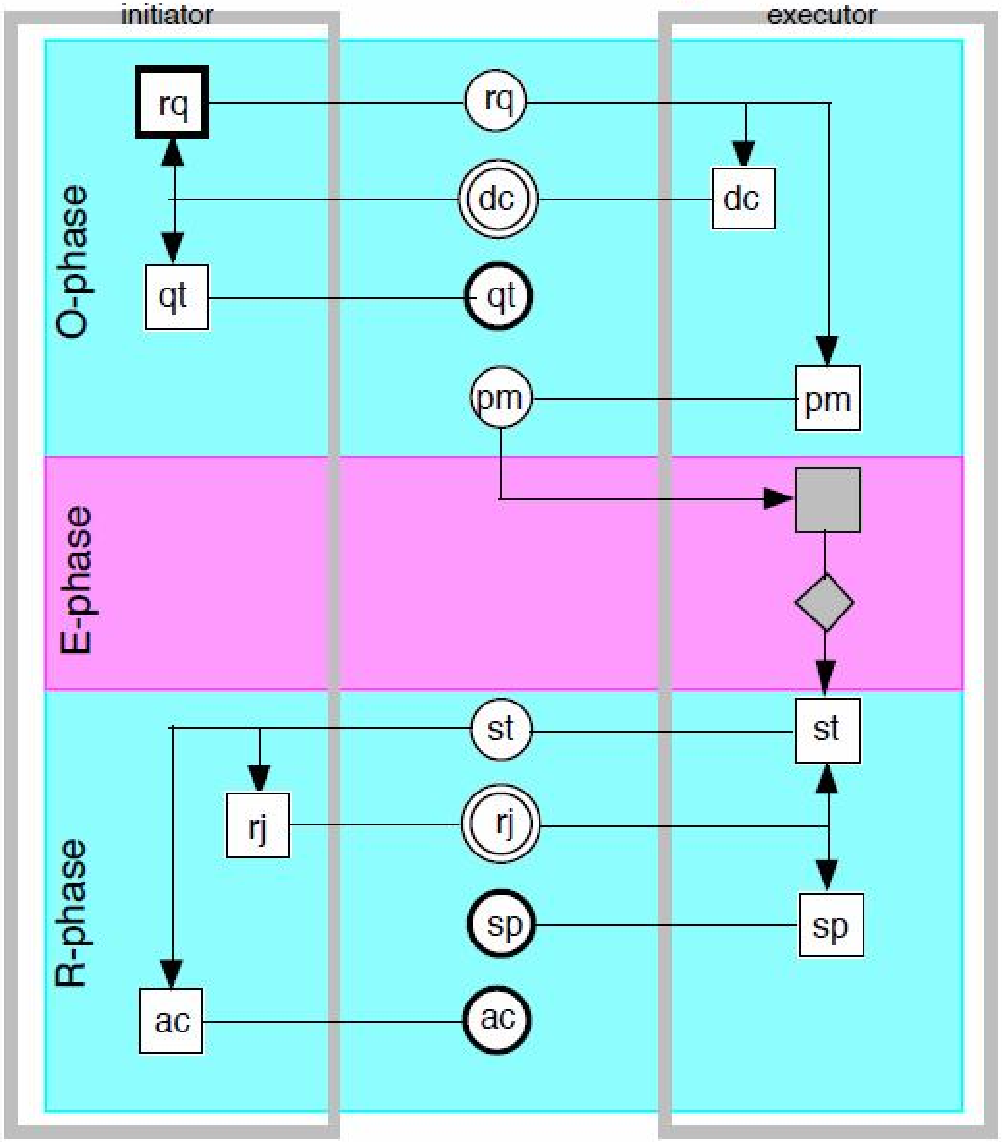
ENTERPISE ONTOLOGY AXIOMS

1. The distinction axiom based analysis: per-info-forma
2. The operation axiom: performa divides to coordination things P-acts and production things P-facts (note signs)
3. The 1st transaction axiom based synthesis : P-acts ⟶ P-facts (result hierarchy)
4. The composition axiom based analysis: part-of relationship (BOM hierarchy tree)
5. The 2nd transaction axiom based synthesis: initiator/executor
6. The enterprise based synthesis

The transaction axiom



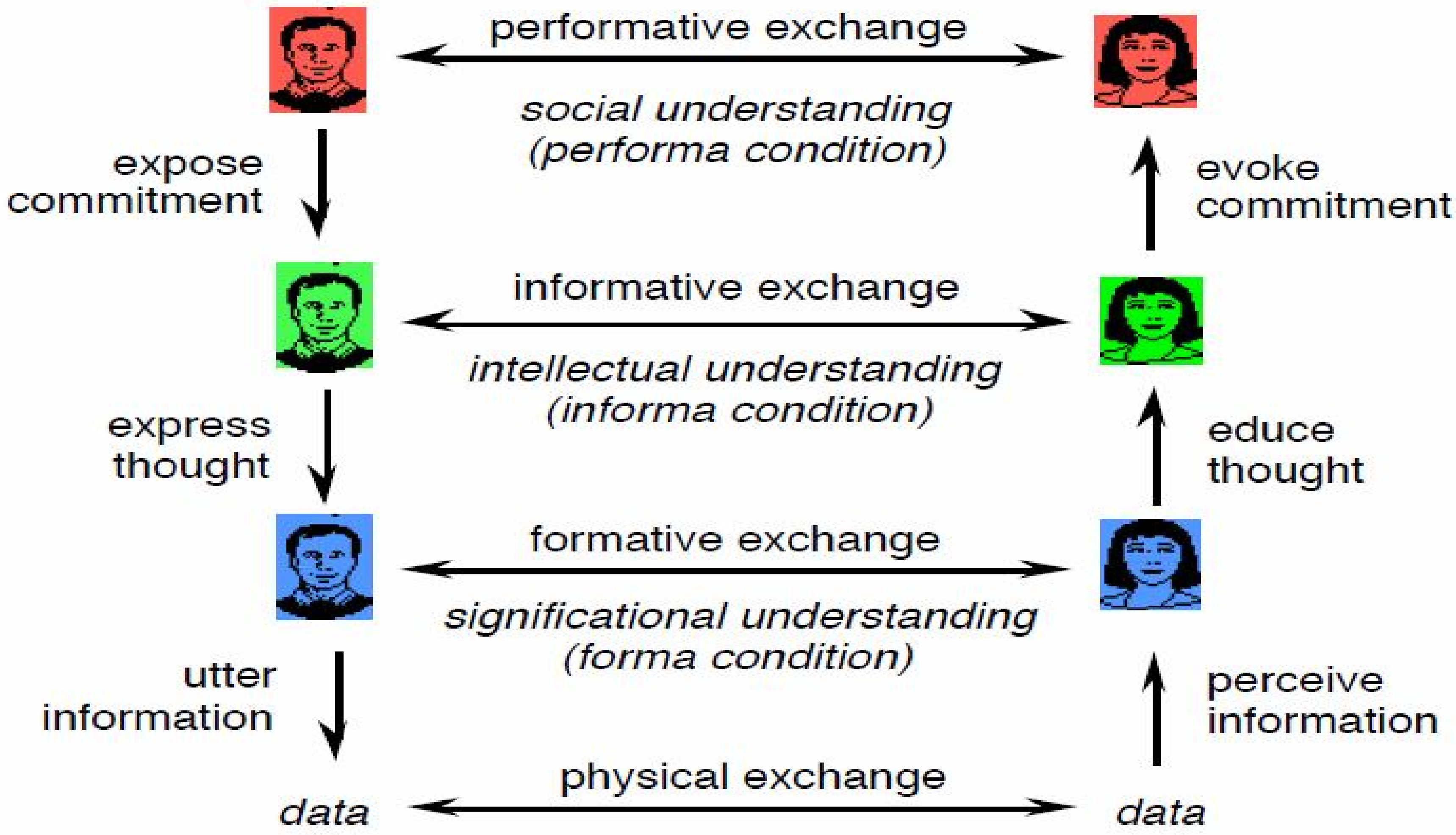
The standard transaction pattern



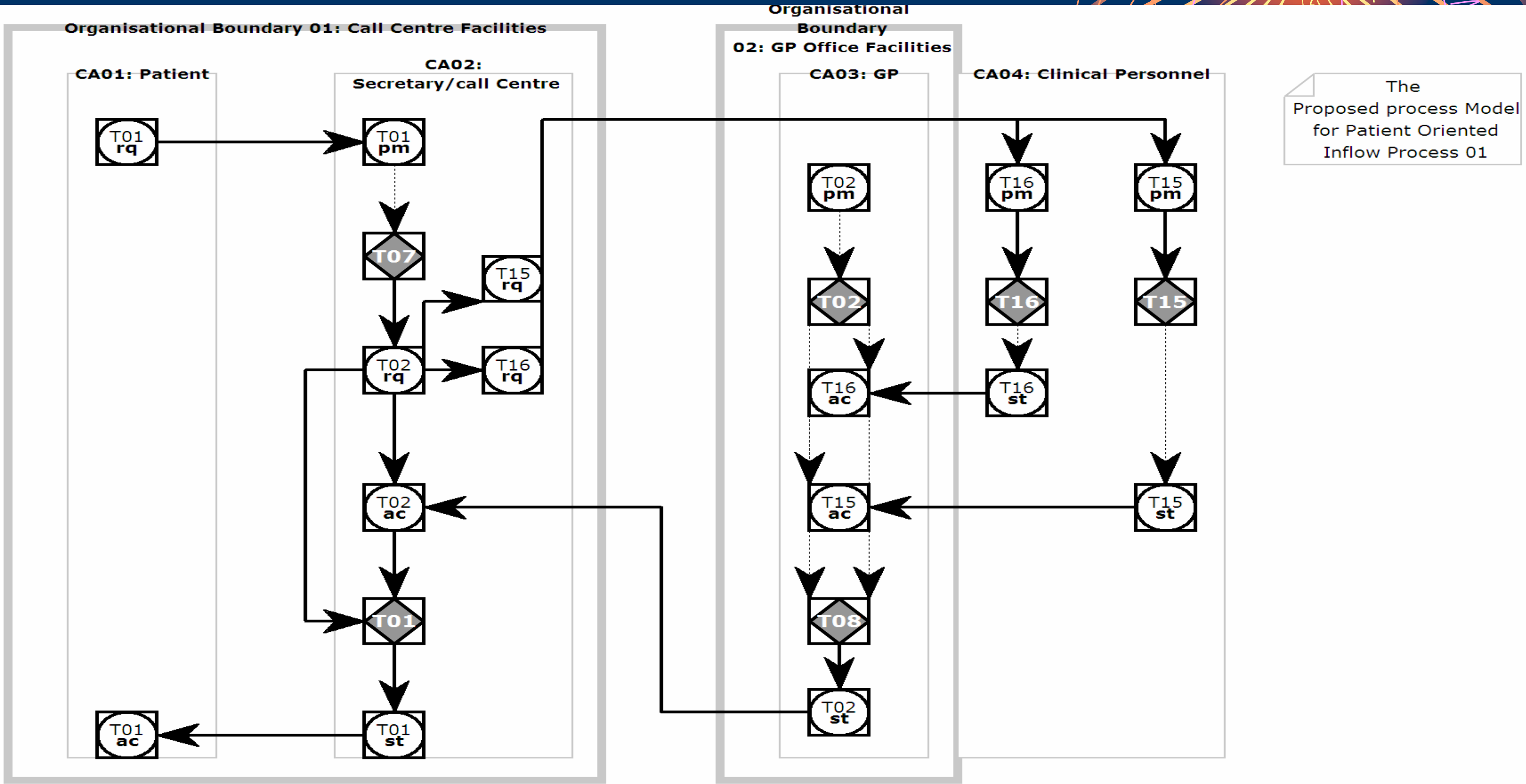
rq: request
pm: promise
dc: decline
qt: quit

st: state
ac: accept
rj: reject
sp: stop

Performing a coordination act



NHS ENTERPISE ONTOLOGY EXAMPLE



DEMO ENTERPISE ONTOLOGY BPR BENEFITS

- **Essential**: DEMO extracts the ontological essence of an organisation from its realisation and its technology dependent implementation
- **Complete** : the generic socionomic pattern of the DEMO transaction warrants completeness of the ontology
- **Modular** : DEMO presents organizations as compositions of universal, atomic' and molecular building blocks
- **Coherent** : Aspect organisations (ontological, infological, datalogical) of DEMO constitute an integrated whole
- **Consistent** : The distinct aspect models warrants consistency
- **Objective** : It is well structured
- **Participative** : The DEMO architect is a facilitator. The work is a learning process among the human resources
- **Optimal** : DEMO are low cost reengineering projects

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Appendix 4: Prototype Report of US Design, Xemod 2008: Contemporary Process 03

1. DEMO - Design & Engineering Methodology for Organizations

1.1. Introduction to DEMO20

Design & Engineering Methodology for Organizations (DEMO) is a methodology for organization engineering, developed at Delft University of Technology by prof.dr.ir. Jan L.G. Dietz. The way of thinking of the method is based on the Language/Action Perspective (LAP) founded by language philosophers such as John Searle and Jurgen Habermas.

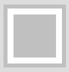
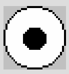
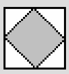
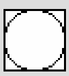
1.2. Process Structure Diagram

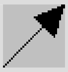
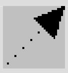
The DEMO Process Structure Diagram (PSD) shows the coordination acts and the production act of each transaction. Each transaction follows a predefined order of coordination acts, broken by a single production act. The success path of a transaction is a sequence that consists of two coordination acts, request and promise, followed by a production act, which is followed again by two coordination acts, state and accept.

By drawing reaction links it is possible to specify that one act leads to another act. The wait link is used to specify that a certain act has to wait on the completion of another act.

The legend of the Process Structure Diagram is as follows:

Appendix 4

Symbol	Name	Description
	Organization Boundary	The organization boundary defines the border of the business system that is modelled. It is the boundary between the actors and transactions that belong to the organization and those that belong outside the system (the system environment). It is used in both in the Detailed Actor Transaction Diagram to draw a boundary between those actors that belong to the organization and those not, and in the Process Structure Diagram to draw a border between those coordination acts that belong to the organization and those not.
	Activation	The initial state of a business process viewed as a pattern of coordination and production acts.
	Production Act+Fact	The combination of a production act and its resulting state. Each transaction consists of one production act. E.g. the production act 'deliver goods' and the resulting state 'goods are delivered' in a 'delivery' transaction.
	Responsibility Area	The responsibility area defines the border of the actor that is modelled. It is used to draw a border between those coordination acts that belong to the actor and those not.
	Coordination Act+Fact	The combination of a coordination act and its resulting state, as part of a certain transaction between two actors. E.g. the coordination act 'request' and the resulting

		state 'requested' as part of the transaction 'deliver goods'.
	Causal link	A wait link in the Process Structure Diagram (PSD) specifies precedence between two coordination acts in a transaction. The coordination acts 'request' (by the initiating actor) followed by a 'promise' (of the executing actor), the production act (of the executing actor) followed by a 'state' (of the executing actor), followed by an 'accept' (by the initiating actor) is the default precedence of coordination acts within a transactions, called the 'success path' of a transaction.
	Conditional link	A wait link in the Process Structure Diagram (PSD) specifies that the performing of a coordination act in one transaction has to wait until the other transaction is in a certain state. For example, the 'promise' coordination act in the transaction 'buy car' can only be carried out when the 'accept' coordination act in the transaction 'check creditability' is carried out.

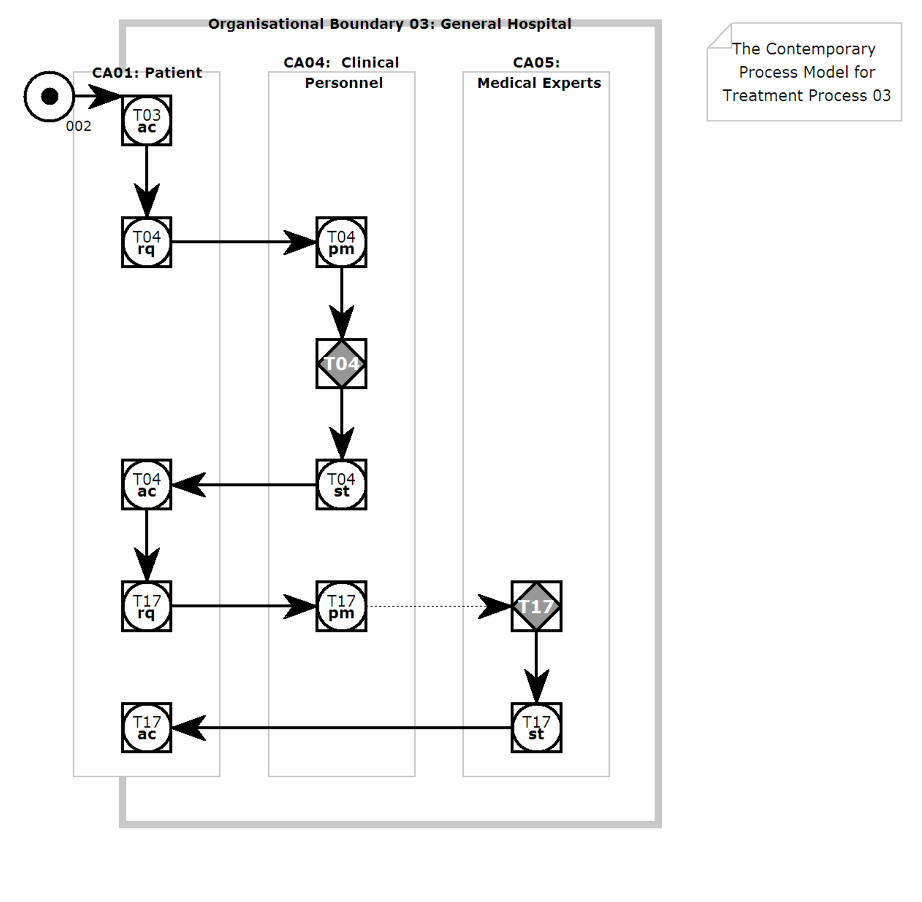


Figure 1-1: The Contemporary Process Model for Treatment Process 03

Description Organisational Boundary 03: General Hospital

It is the general hospital's facilities

Description 002

the patient initiates this act once he/she received the patient referral for futher treatment

Description T04: Hospital Inflow

Eventually, besides the above "conditional" admittance, when the patient is admitted and transactionT04 is executed the patient receives a room, doctor and other hospital tangible and intangible resources according to the availability at that time. All expenses for the resources provided are 100% substituted by the patient's public insurance.

Description T17: Treatment Performance

Upon treatment execution the actor "doctor" that is the initiator of this act informs orally the patient relative to operation procedures. This communication is always informal and is of a psychological nature rather than of a medical one. Then the operation takes place without any specific patient disclosed medical methodology.

Description CA05: Medical Experts

The expert doctor's that are responsible for the patien'ts treatment

Description Accept T03: Doctrors Referral for Further Treatment

Once the patient accepts the doctor's referral the next step is the hospital inflow. The patient leaves the doctor's public office that is most of the times inside the general hospital that the patient will be admitted and communicates with the clinical personnel.

Description Request T04: Hospital Inflow

Eventually, besides the above "conditional" admittance, when the patient is admitted and transactionT04 is executed the patient receives a room, doctor and other hospital tangible and intangible resources according to the availability at that time. All expenses for the resources provided are 100% substituted by the patient's public insurance.

Description Promise T04: Hospital Inflow

Many times this promise for hospital admittance is not an immediate one due to usual patient overload of the general hospitals. There is currently lack of any formal process, besides the formal patient registration at the hospital's record, for priority or hierarchical arrangement for the general hospital's admittance. That means that this promise for patient inflow is trivial, oral and although the patient case is registered accordingly to the hospital's records the patient has no formal form or any other type of document that informs him /her at least vaguely for the admittance date. If there is a need for an immediate hospitalisation then there is a good chance that the patient will be accepted "conditionally" in a bed located many times in the hospital's corridors. Although not the optimal option the patient receives immediate hospitalisation until a proper bed is in order. It is still although at transaction T04 promise status until further notice. Based on this current T04 current situation it is not unusual for the patient to wait for a long period of time for treatment for several obvious reasons due to lack of formal measures or formal data that inform the patient about the progress of this transaction status. It is also not unusual for the patient that if this period is prolonged to leave the public healthcare and enter the private one.

Description State T04: Hospital Inflow

Once the patient is admitted an announcement of the potential treatment is done orally by the clinical staff. The doctor that is assigned to that patient's case, in the best case scenario meets the patient in person minutes before operation time. Generally the patient is vaguely aware of the hospital flow and treatment horizon. Any requests for specific hospital resources are simply not possible or operate on a trivial status. So this act is a public healthcare statement that is a fact without any measurements in effect.

Description Accept T04: Hospital Inflow

The patient accepts the statement and requires of course performance treatment the soonest possible.

Description Request T17: Treatment Performance

The patient orally requests performance treatment as mentioned above. The situation is that as the T04ST is a fact, an informal and most of the times unnecessary negotiation for priority arrangements for performance treatment occurs. Sometimes although it is possible, for reasons outside the scope of this study, through this informal act (T18 RQ) the patient manages to receive better electronically recorded treatment performance horizon or even the doctor requested. The T17 transaction is not electronically recorded.

Appendix 4

Description Promise T17: Treatment Performance

The clinical staff promises that the hospital's oral treatment plan or rather promise will be followed. Alternately the patient request due to the previous act is also an option.

Description State T17: Treatment Performance

Once the previous execution step is finished then the initiator of this act that is again the doctor states the result. That means that if the treatment execution result is positive everything is well done. On the contrary if the treatment execution fails then the patient holds no formal data as evidence for potential malpractice and this acts ends at this point.

Description Accept T17: Treatment Performance

The patient that initiates that act accepts the result of the operation. If the result is positive then the patient receives on paper couple of guidelines, less than a page usually, and the dismissal transaction is in order. If the electronically recorded treatment performance is unsatisfactory a variety of situation, not directly relevant to the scope of this study may occur. Due to lack of transactions relating to medical evidence based results, the performance treatments from general hospitals could easily be biased or even manipulated and the patient has to accept them. This is the situation currently for the treatment process in Greece. For the record, many outstanding court cases for malpractice in public general hospitals are in order due to this contemporary situation.

Appendix 5: Prototype Report of OS Design, Xemod 2008: Propose Process Model 03

1. DEMO - Design & Engineering Methodology for Organizations

1.1. Introduction to DEMO20

Design & Engineering Methodology for Organizations (DEMO) is a methodology for organization engineering, developed at Delft University of Technology by prof.dr.ir. Jan L.G. Dietz. The way of thinking of the method is based on the Language/Action Perspective (LAP) founded by language philosophers such as John Searle and Jurgen Habermas.

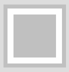
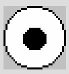
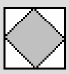
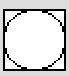
1.2. Process Structure Diagram

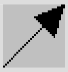
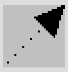
The DEMO Process Structure Diagram (PSD) shows the coordination acts and the production act of each transaction. Each transaction follows a predefined order of coordination acts, broken by a single production act. The success path of a transaction is a sequence that consists of two coordination acts, request and promise, followed by a production act, which is followed again by two coordination acts, state and accept.

By drawing reaction links it is possible to specify that one act leads to another act. The wait link is used to specify that a certain act has to wait on the completion of another act.

The legend of the Process Structure Diagram is as follows:

Appendix 5

Symbol	Name	Description
	Organization Boundary	The organization boundary defines the border of the business system that is modelled. It is the boundary between the actors and transactions that belong to the organization and those that belong outside the system (the system environment). It is used in both in the Detailed Actor Transaction Diagram to draw a boundary between those actors that belong to the organization and those not, and in the Process Structure Diagram to draw a border between those coordination acts that belong to the organization and those not.
	Activation	The initial state of a business process viewed as a pattern of coordination and production acts.
	Production Act+Fact	The combination of a production act and its resulting state. Each transaction consists of one production act. E.g. the production act 'deliver goods' and the resulting state 'goods are delivered' in a 'delivery' transaction.
	Responsibility Area	The responsibility area defines the border of the actor that is modelled. It is used to draw a border between those coordination acts that belong to the actor and those not.
	Coordination Act+Fact	The combination of a coordination act and its resulting state, as part of a certain transaction between two actors. E.g. the coordination act 'request' and the resulting

		state 'requested' as part of the transaction 'deliver goods'.
	Causal link	A wait link in the Process Structure Diagram (PSD) specifies precedence between two coordination acts in a transaction. The coordination acts 'request' (by the initiating actor) followed by a 'promise' (of the executing actor), the production act (of the executing actor) followed by a 'state' (of the executing actor), followed by an 'accept' (by the initiating actor) is the default precedence of coordination acts within a transactions, called the 'success path' of a transaction.
	Conditional link	A wait link in the Process Structure Diagram (PSD) specifies that the performing of a coordination act in one transaction has to wait until the other transaction is in a certain state. For example, the 'promise' coordination act in the transaction 'buy car' can only be carried out when the 'accept' coordination act in the transaction 'check creditability' is carried out.

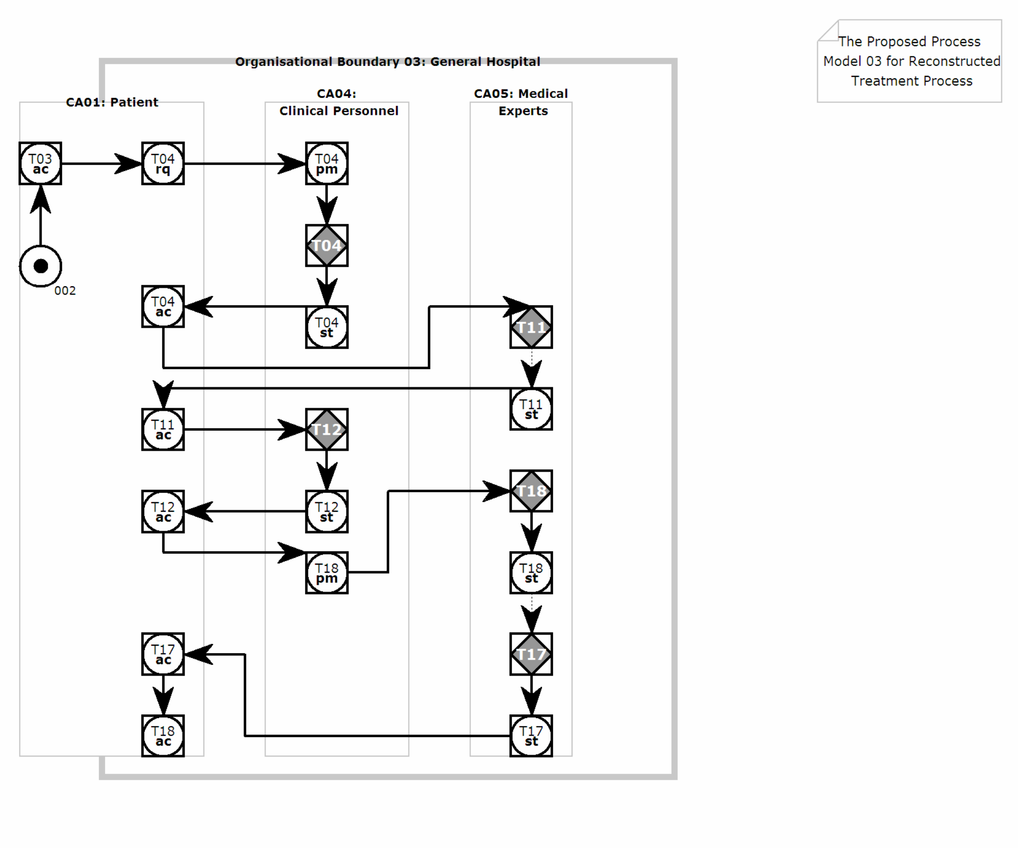


Figure 1-1: The Reconstructed Treatment Process 03

Description Organisational Boundary 03: General Hospital

It is the general hospital organisation and all the actors responsibility area follows the rules and documentation of the hospital

Description 002

The patient initiates this act by giving the GP referral to the general hospital for admitance.

Description T04: Hospital Inflow

At this step the initiator actor "clinical personnel" executes the necessary acts for preparing inflow transaction and registration for accepting the patient condition to the hospital's records. As the patient is already aware of the hospital's profile that means that the lead time for hospital inflow activities is within the time limits of the patient's condition type.

Appendix 5

Description T12: Electronic Project Management Treatment

The execution of the verification of treatment process and medical operations is initiated without any specific request as a standard operating procedure from the clinical personnel of the specific general hospital that the patient is admitted.

Description T11: Initiation of patients Treatment Cycle

The actor of this transaction is the "medical expert", specifically the doctor that will be assigned from the public hospital to execute the treatment operation. If the patient proceeds with a private doctor or has the option of choosing the doctor that will operate the treatment, this act remains the same.

Description T18: Electronically recorded Narration of Treatment Methodology

All of these actions of the transactions are initiated from the medical experts, except from T18 PM that is initiated from the clinical personnel. This tertiary operating procedure's analysis is outside the scope of this study as it is directly relevant to the implementation and control of the primary processes included in this ontological framework (See table 9.2). It is also concerning the tacit rather than the explicit knowledge of the patient flow that this study aims to analyse.

Description T17: Electronically Recorded Treatment Performance

This standard tertiary process also concerns the actual transaction of the electronically recorded treatment performance (See table 9.2). It results to the safe medical operation. The initiator of this act is the doctor who is also responsible for: 1. The explicit knowledge of the safety procedures for the patient's operation 2. The tacit knowledge which is recorded through the standard operating transaction of T19. That way the doctor turns conditionally this act in to a fact if all relevant measures that follow in the next section are in order. The patient orientation of this process is underlined though this proposed restructuring. Besides the fact that transactions T12, T13, T18, T19, are novel ones the hierarchy of these transactions assures patient orientation. The patient is always aware of the next patient flow act in away that is able to take an informed decision. Thus it is not possible for the patient to leave this process as he/she has to follow the doctor's tacit knowledge from T12 transaction until T19 transaction through a recorded document of this flow. That way if treatment is not successful he/she could seek justice in case of malpractice.

Description CA05: Medical Experts

The medical experts are the ones that with their tacit knowledge inform the patient about possible altenative treatment scenarios and operation methods

Description Accept T03: Doctors referral for Further Treatment

Once the patient accepts the transaction's result of the "treatment referral" document the next step is the hospital inflow. The patient leaves the doctor's public office that is inside the general hospital most of the times and communicates with the appropriate clinical personnel. This step is identical to the contemporary's situation.

Description Accept T04: Hospital Inflow

The informed "patient" is now going to accept the statement and proceed with the transaction. Alternatively based on the "POMR communication record" which is not delivered properly and the lead time exceeded the patient condition limits could reject and terminate the specific hospital transaction. So at this point the patient is treated in a patient oriented way if all measures are as expected. Else in a case of measurement's failure the patient rejects the transaction. As the patient was not having the availability of these the "POMR communication record" and there was no formal NHS available information regarding the hospital's status there was not a patient oriented strategy in order.

Description State T04: Hospital Inflow

At this point the "clinical personnel" will state the process of the hospital inflow. This statement due to the previous act of this transaction makes sense to the listener "patient" as there is a certain level of awareness that is possessed due to the hospital measures reporting. It is also the hospital's responsibility to orally provide the necessary benchmarking data and its comparative rating, so that the patient could understand the level of hospital operation regarding to his/her condition.

Description Promise T04: Hospital Inflow

At this step the initiator actor "clinical personnel" executes the necessary acts for preparing inflow transaction and registration for accepting the patient condition to the hospital's records. As the patient is already aware of the hospital's profile that means that the lead time for hospital inflow activities is within the time limits of the patient's condition type.

Description Request T04: Hospital Inflow

Upon patient request, based on doctor's "treatment referral", the clinical personnel inform the patient when the hospital inflow process will occur based to the hospital records as in the current situation analysis. The patient is already aware through "POMR2" and "POMR3" reports, due to doctor's treatment proposal from core transaction three (T03) and its subs transaction's about the hospital's profile.

Description Accept T11: Initiation of patients Treatment Cycle

The initiator of this act is the patient. Once all the knowledge relevant to his/her condition is in order then the patient should accept the situation and proceed with the next transaction. There is theoretically no chance that the patient declines this act as he/she accepted the doctor's treatment proposal at an earlier transaction step of this process (see T04 ACC).

Description State T11: Initiation of patients Treatment Cycle

It is important that the the "POMR communication record" counselling with reference to safety and malpractice measures is taking place from an actor that will be on the expert team that will perform the treatment ("clinical personnel" or "expert doctor" actors). The agenda of this act will include an oral, "electronically recorded treatment process" dialogue of the doctor explaining the treatment method to be followed for optimal patient treatment.

Appendix 5

Description Accept T12: Electronic Project Management Treatment

The initiator of this act is the clinical personnel which have to deliver the "electronically recorded treatment process". This act turns in to fact immediately with the patient acceptance and the step: T12ACC: Electronic Verification of Treatment Process and Medical Operations.

Description State T12: Electronic Project Management Treatment

The initiator of this act is the clinical personnel which have to deliver the "electronically recorded treatment process". This act turns in to fact immediately with the patient acceptance and the step: T12ACC: Electronic Verification of Treatment Process and Medical Operations.

Description Accept T17: Electronically Recorded Treatment Performance

This standard tertiary process also concerns the actual transaction of the electronically recorded treatment performance (See table 9.2). It results to the safe medical operation. The initiator of this act is the doctor who is also responsible for: 1. The explicit knowledge of the safety procedures for the patient's operation 2. The tacit knowledge which is recorded through the standard operating transaction of T19. That way the doctor turns conditionally this act in to a fact if all relevant measures that follow in the next section are in order.

Description State T17: Electronically Recorded Treatment Performance

This standard tertiary process also concerns the actual transaction of the electronically recorded treatment performance (See table 9.2). It results to the safe medical operation. The initiator of this act is the doctor who is also responsible for: 1. The explicit knowledge of the safety procedures for the patient's operation 2. The tacit knowledge which is recorded through the standard operating transaction of T19. That way the doctor turns conditionally this act in to a fact if all relevant measures that follow in the next section are in order. The patient orientation of this process is underlined though this proposed restructuring. Besides the fact that transactions T12, T13, T18, T19, are novel ones the hierarchy of these transactions assures patient orientation. The patient is always aware of the next patient flow act in away that is able to take an informed decision. Thus it is not possible for the patient to leave this process as he/she has to follow the doctor's tacit knowledge from T12 transaction until T19 transaction through a recorded document of this flow. That way if treatment is not successful he/she could seek justice in case of malpractice.

Description Accept T18: Electronically recorded Narration of Treatment Methodology

The initiator of this act is the patient. As he/she requires the recorded document of the treatment methodology the minimum requirement for this transaction results to patient's awareness of the full treatment cycle and medical operations. As the clinical personnel will deliver the recorded documents to the patient this result is accomplished. The patient accepts the result of the operation without any reservation as there is always the potential of reconsidering the doctor's tacit knowledge. That is possible as the patient before accepting the result of this process is already aware of all the medical operations as transaction step T18ACC precedes this act (See figure 9.11).

Description State T18: Electronically recorded Narration of Treatment Methodology

All of these actions of the transactions are initiated from the medical experts, except from T19 PM that is initiated from the clinical personnel. This tertiary operating procedure's analysis is outside the scope of this study as it is directly relevant to the implementation and control of the primary processes included in this ontological framework (See table 9.2). It is also concerning the tacit rather than the explicit knowledge of the patient flow that this study aims to analyse.

Coordination Act+Fact	Business Rule	Work Instruction
Accept T03: Doctors referral for Further Treatment	On accepted T03 with request T04 no	The patient has to proceed with the doctor's referral to the proposed hospital. This transaction resulted to a patient treatment proposal based on POMR2.
Accept T04: Hospital Inflow	-	If the measurements are within the acceptable limits then the result of patient

		oriented room allocation and registration should be a fact at this point.
State T04: Hospital Inflow	On executed T04 (DP) if and available then state T04 (OP) no	The clinical personnel provides the necessary hospital documentation required at this step
Promise T04: Hospital Inflow	On promised T04 (DP) execute T04 (DP) no	preparation of inflow transaction and registration for accepting the patient condition to the hospital's records
Request T04: Hospital Inflow	On requested T04 (DP) with then promise T04 (DP) no	-
Accept T11: Initiation of patients Treatment Cycle	-	With out any business rule this phase results to the patient accepting the initiation of the treatment process. Then without any further request the patient is ellectronically monitored through this process assuming that the POMR2 reporting formula stands and there is patient data confidentiality
State T11: Initiation of patients Treatment Cycle	On executed T11 (OP) if exists then state T11 (OP) no	The quality of information is subject to the doctor's tacit knowledge and it could be

		used in a case where the hospital's malpractice measures are higher than average as the following section will analyse.
Accept T12: Electronic Project Management Treatment	On accepted T12 (OP) promise T18 (OP) no	This act is automated and as the electronic project management treatment is in order that means that results to a patient record of all the medical transactions that will occur. So there is no reason for the patient not to accept this transacgtion as it is for crystal clear quality information.
State T12: Electronic Project Management Treatment	On executed T12 (OP) if exists then state T12 no	-
Accept T17: Electronically Recorded Treatment Performance	On stated T17 (TP) then accept T17 (TP) no	This work instruction results to patient awareness of the medical performance
State T17: Electronically Recorded Treatment Performance	On executed T17 (OP) if exists then state T17 no	This standard tertiary process also concerns the actual transaction of the electronically recorded treatment performance (See table 9.2). It results to the safe medical operation.

Appendix 5

Accept T18: Electronically recorded Narration of Treatment Methodology	On Stated T17 then accept T18 no	The patient accepts the communication record that provides all the tacit and explicit knowledge of the patient treatment process. it results to the patient's full awareness of medical performance
State T18: Electronically recorded Narration of Treatment Methodology	On executed T18 (OP) if exists then state T18 (OP) no	This tertiary operating procedure's analysis is outside the scope of this study as it is directly relevant to the implementation and control of the primary processes included in this ontological framework
Promise T18: Electronically recorded Narration of Treatment Methodology	-	-

Appendix 6: The prototype in CD “POMRS-Ontology”

The POMRS-Ontology prototype is included in the attached CD. The CD has a folder that includes two subfolders. The one is **CLIPS** subfolder and the other is the **Xemod,** 2008 subfolder**.**

In the **CLIPS** folder the user could find all the reports generated and described in implementation chapter 7. In order to do so electronically the user opens the “run” file included in CLIPS sub folder which automatically loads all the ontological action rules, (see: appendix 1), based on the ontological redesign of the OS. Once the initial screen appears, at the upper left corner of the screen, the user presses the load button to load the system rules. Next to this button it is the trace button that shows the rules design. Then, according to the implementation chapter 7, the user could generate and navigate through these prototype reports and the system’s measures implementation examples.

The **Xemod**, 2008 folder includes 5 sub files:

- The ATD sub file. It includes the total structure of the model at the “proposed action transaction diagram” sub file, its supporting report and a sub file with all the datalogical documents of the OS redesign.

- The 4 processes sub files. These four sub files include the four core processes with their full ontological redesign at all levels and their supporting data-logical documents and infological reports. Indicative prototype reports of the US and the OS redesigned process 3 are also attached in hard copy at appendices 4 and 5. All documentation and information generation is included in the word documents of each process. The Xemod files include the US and the OS designs which are exhibited in chapters 5 and 6 figures.

In order for the user to open and see electronically these ontological designs he needs to download the student version of Xemod 2008 which is strictly personal and is not allowed to be copied from the researcher into the prototype CDs at: http://www.xprise.com/upload/nl/pages/tblMenuitems_F4E934DBEF/ tblPages_ AC4624994D/1_file.pdf

Appendix 7: POMR Framework Evaluation Questionnaire

Respondent Data

- **Position:…………………………..**
- **Age:……………………………….**
- **Education:………………………..**
- **Date:………………………………**

Directions

You have already presented the US design of the contemporary situation and the POMR novel framework design (OS). Please fill the following questionnaire regarding your experience and the use and structure of the POMR framework. Please Tick the selected choice.

<u>Part 1: Functional Completeness</u>

1. The US division of the four core processes reflects the contemporary situation.

    a. I agree
    b. I partly agree
    c. I disagree

Comments:………………………………………………………………………
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2. The US core transactions reflect the contemporary situation.

    a. I agree
    b. I partly agree
    c. I disagree

Comments:………………………………………………………………………
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3. Please state your opinion about the functional completeness of the novel framework (OS). At this part you are required to evaluate the

competence between the POMRS supporting information system and its POMR model's assistance to ontological level of decision making.

a. The POMR transaction results are not competent to the POMRS evaluating measures and thus I can not make a proper decision at each transaction…….. Please specify the problematic transaction numbers:......
b. The transaction results are competent with the evaluating measures by the help of the author only…..Please specify the problematic transaction numbers:....
c. The transaction results are competent to the evaluating measures and I can easily understand their value-added…..

Comments:……………………………………………………………..
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4. Please state your opinion about the relevance of the POMRS supporting information system measures and their relevance to POMR transactions for the implementation of the patient-orientation concept of this novel framework (OS).

   a. The POMRS is directly relevant to the transactions of the POMR model for this framework's concept implementation
   b. The POMRS is not directly relevant to the transactions of the POMR model for this framework's concept implementation
   c. The POMRS is not directly relevant at all to the transactions of the POMR model for this framework's concept implementation

   Comments:…………………………………………………………………
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Part 2: Generality (Doctors Only)

In this part of the questionnaire you are asked to inform us about your perceptions on how this ontology approach and specifically the redesigned novel framework (OS) assist to the communication improvement between patient and the healthcare stakeholders minimising the amount of queries which are currently present to the US due to lack of such flow design.

1. <u>This question refers to the Proposed Process 01: Patient Oriented Inflow.</u> The “patient” actor in this novel ontological framework (OS) sub-process is serviced proactively eliminating thus potential questions relevant to alternative flow paths.

    a. I agree
    b. I partly agree
    c. I disagree

    Comments:……………………………………………………………………
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2. <u>This question refers to the</u> <u>Proposed. Process 02: Patient Treatment Referral.</u> The “patient” actor in this novel ontological framework (OS) sub-process is serviced proactively eliminating thus potential questions relevant to alternative flow paths.

    a. I agree
    b. I partly agree
    c. I disagree

    Comments:……………………………………………………………………
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3. <u>This question refers to the Proposed Process 03: The Redesigned Treatment Process</u>. The “patient” actor in this novel ontological framework (OS) sub-process is serviced proactively eliminating thus potential questions relevant to alternative flow paths.

    a. I agree
    b. I partly agree
    c. I disagree

    Comments:……………………………………………………………………
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4. This question refers to Proposed Process 04: The Patient-oriented Outflow Process. The “patient” actor in this novel ontological framework (OS) sub-process is serviced proactively eliminating thus potential questions relevant to alternative flow paths.

   a. I agree
   b. I partly agree
   c. I disagree

   Comments:………………………………………………………………………
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Part 3: Efficiency.

You have already presented the US design of the contemporary situation and the POMR novel framework design (OS). Please fill the following questionnaire regarding the efficiency of the novel model transactions (POMR) and their supporting information system (POMRS). Please Tick the selected choice.

1. This question refers to the Proposed Process 01: Patient Oriented Inflow has no obvious efficiency gaps.

   a. I agree
   b. I partly agree
   c. I disagree

   Comments:………………………………………………………………………
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2. This question refers to the Proposed. Process 02: Patient Treatment Referral has no obvious efficiency gaps.

   a. I agree
   b. I partly agree
   c. I disagree

   Comments:………………………………………………………………………
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3. This question refers to the Proposed Process 03: The Redesigned Treatment Process has no obvious efficiency gaps.

    a. I agree
    d. I partly agree
    e. I disagree

Comments:…………………………………………………………………………
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4. This question refers to Proposed Process 04: The Patient-oriented Outflow Process has no obvious efficiency gaps.

    a. I agree
    b. I partly agree
    c. I disagree

Comments:…………………………………………………………………………
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Part 4: Perspicuity

You have already presented the US design of the contemporary situation and the POMR novel framework design (OS). Please fill the following questionnaire regarding the perspicuity of the novel model transactions (POMR) and their supporting information system (POMRS). Please Tick the selected choice

1. This question refers to the Proposed Process 01: Patient Oriented Inflow. The role and the action rules relevant to the span of each actor's activity are clear

    a. I agree
    b. I partly agree
    c. I disagree

Comments:……………………………………………………………………………
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2. This question refers to the Proposed. Process 02: Patient Treatment Referral. The role and the action rules relevant to the span of each actor's activity are clear.

   a. I agree
   b. I partly agree
   c. I disagree

Comments:……………………………………………………………………………
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3. This question refers to the Proposed Process 03: The Redesigned Treatment Process. The role and the action rules relevant to the span of each actor's activity are clear.

   a. I agree
   b. I partly agree
   c. I disagree

Comments:……………………………………………………………………………
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4. This question refers to Proposed Process 04: The Patient-oriented Outflow Process. The role and the action rules relevant to the span of each actor's activity are clear.

   a. I agree
   b. I partly agree
   c. I disagree

Comments:…………………………………………………………………………
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Part 5: Precision

You have already presented the US design of the contemporary situation and the POMR novel framework design (OS). Please tick with **V** the OS transaction types which according to your opinion are primitive in their nature. That means that they **do not conceptually overlap** with other OS transactions. Tick with an **X** the transactions that they **do conceptually overlap** each other. Please comment at the end the reasons for crossing them.

TRANSACTION TYPE **RESULT TYPE**

T1 Healthcare appointment management	R1 Initiation of a patient relationship management
T2 E P R analysis	R2 Complete patient record
T3 Doctor's referral for further treatment	R3 Patient treatment proposal based on POMR2
T4 Hospital inflow	R4 Patient-oriented hospital registration and room allocation
T5 Hospital discharge and/or rehabilitation treatment initiation	R5 Patient treatment and/or outpatient hospital rehabilitation procedures report program
T6 Patient relationship monitoring	R6 Verification of rehabilitation procedures and delivery of POMR1, POMR4
T7 Patient record management	R7 Storage, indexing, retrieval of patient records
T8 Information retrieval from NHS bill of examination data base	R8 Interpret information based on expertise
T9 Patient Examination	R9 Diagnosis of the patient's problem
T10 Patient-oriented measurements analysis for patient condition	R10 Treatment proposal based on relevant POMR3
T11 Initiation of patient's treatment cycle	R11 Patient POMR based counselling
T12 Electronic study management	R12 Electronic verification of treatment

treatment	process and medical operations
T13 Proactive treatment continuation	R13 Prevention plan.
T14 Doctor's expert opinion	R14 Patient quality communication
T15 Laboratory tests	R15 Safe laboratory results
T16 Clinical tests	R16 Safe clinical results
T17 Electronically recorded treatment performance	R17 Patient's awareness of medical performance
T18 Electronically recorded narration of treatment methodology	R18 Patient's awareness of the full treatment cycle

Comments:………………………………………………………………………
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In relation to this model's granularity, please check, if possible, to the structure of the proposed model below the transactions which hierarchically do not fit or are misplaced. Please comment on those indicated.

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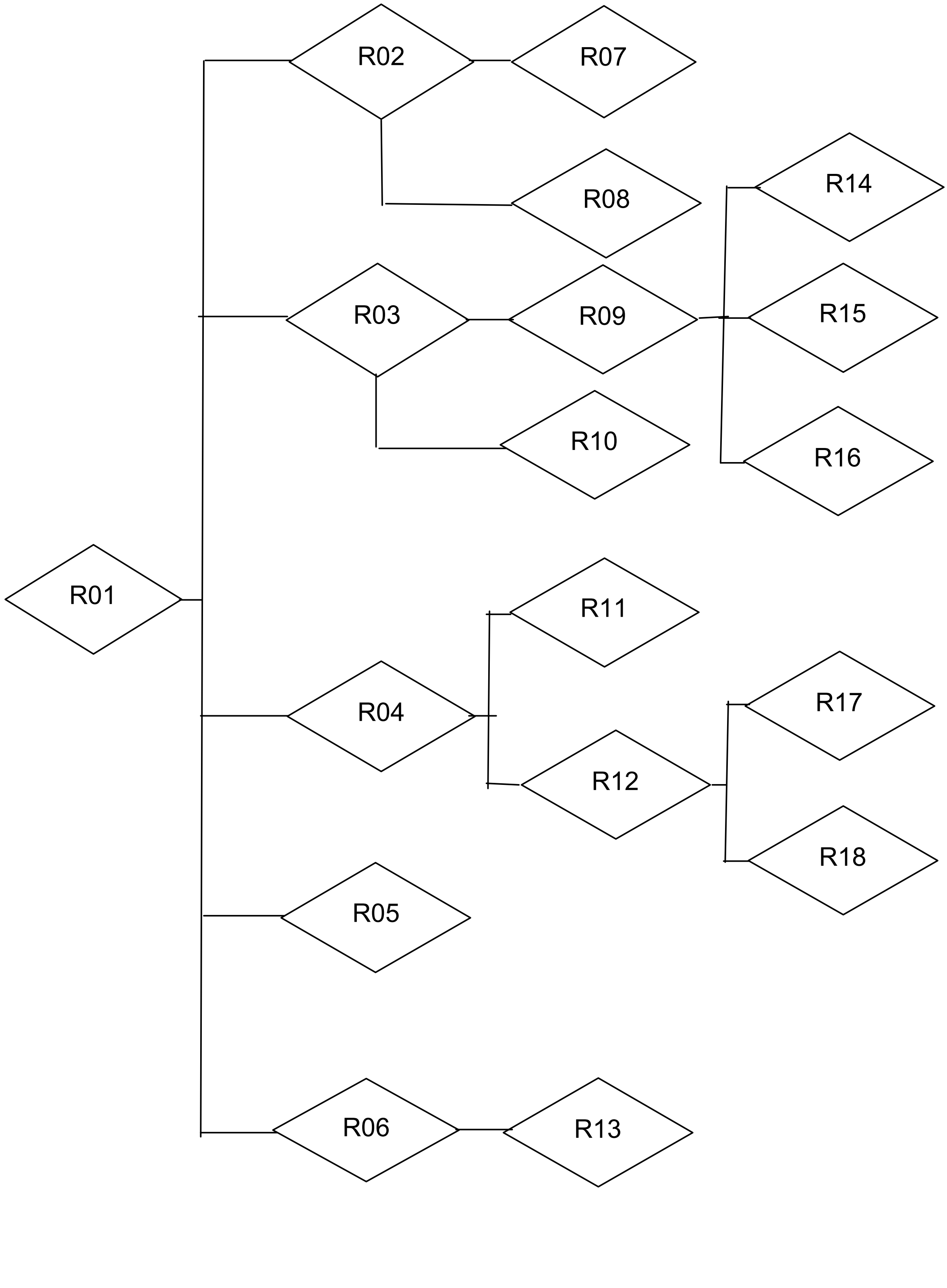
R01
R02
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R18

Part 6: Minimalism

You have already presented the US design of the contemporary situation and the POMR novel framework design (OS). Please tick with a **V** on the side the set of documents (object class at data-logical and info-logical level like reports, paper work, etc.) which are necessary for the patient-orientation concept to be implemented. If there are unnecessary documents or missing ones, in the following hierarchically exhibited according to the OS flow transactions, please indicate them on the comments section.

SET OF DOCUMENTS:

- Appointment date
- Insurance Status
- Documents Complete EPR
- Bill of examinations Examination
- Referral Clinical& Laboratory results
- Patient Condition (P)
- Diagnosed Patient Condition (DP)
- Treatment Referral Clinical& Laboratory results
- Operated Patient Condition (OP)
- Appointment date Diagnosed Patient Condition (DP)Treatment Referral Electronic
- Verification Treatment Process Electronic Record of Methodology
- Electronic Medical Operation Record
- Hospital Treated Patient Condition (TP)
- Discharge Documents
- Hospital Rehabilitation Procedures Report
- Generic Patient Condition Rehabilitation Program Customised Patient Condition Rehabilitation Program
- POMR1
- POMR2
- POMR3
- POMR4

Comments:…………………………………………………………………………
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Appendix 8: Researcher's List of Relevant Publications

1. Papagiannis, F., Danas, K., Roudsari, A. (2005), "The Minimization Of The Time To Market Ratio Using A Supply – Demand Algorithm: A Case Study," 2nd Supply Chain Management and Information Systems Management International Conference, Conference Proceedings, Thessaloniki, Greece, pp. 7-9

2. Papagiannis, F., Danas, K., Roudsari, A. (2005), "Restructuring of The Health Care Sector: A Patient-oriented Approach," Proceedings of the 10th ISIMR 2005, Thessaloniki, Greece, pp. 9-11.

3. Papagiannis, F., Danas, K., Roudsari, A. (2008), "Ontology Based Structure of an Elective Patient Oriented Performance Flow" 13th International Symposium on Health Information Management Research, Conference Proceedings, Auckland, New Zealand, pp 213-225.

4. Papagiannis, F., Roudsari, A, Danas, K. (2011), "National Patient Flow Framework: An Ontological Patient-oriented Redesign," An International Conference addressing Information Technology and Communications in Health, Conference Proceeding, Victoria, Canada (work in progress).

5. Papagiannis, F., Roudsari, A, Danas, K. (2011), "An Ontological Patient-Oriented Flow Redesign," 15th International Symposium on Health Information Management Research, Conference Proceedings, Zurich, Switzerland (work in progress).

Appendix 9: Ethical Approval Form Prototype

1. Name of Study

NATIONAL PATIENT FLOW FRAMEWORK: AN ONTOLOGICAL PATIENT ORIENTED REDESIGN

2. Applicant (Principal Investigator)

2.1 Title: MR
Surname: PAPAGIANNIS
First name: AKIS

2.1.1 Staff:

- [x] University staff — Position: PHD CANDIDATE

2.1.2 Student project:

- [x] Part-time University student
- [x] Post-graduate University student

Name of Program: PhD HEALTHCARE INFORMATICS

Name of academic supervisor: ABDUL ROUDSARI

School/Faculty: CITY UNIVERSITY, LONDON

2.2	Phone number:	0030443857
2.3	Fax number:	0030443857
2.4	E-mail:	Papagiannis@cpaconsulting.gr
2.5	Mailing address:	94 kominon, Thessaloniki, 55132, Greece

3. Brief Summary of Study

Based on ontology, this study will redesign the core patient flow processes with the simultaneous introduction of a patient-oriented model that will conceptualise and implement this ontological framework.

4. Major Ethical Issues

There are no major ethical issues as this study focuses on structural patient oriented flow redesign.

5. Scientific Basis

5.1 Background, current evidence and key references:

A gap regarding scientific, patient-oriented, measurable frameworks has been discovered and demonstrates the need for a new healthcare management framework

5.2 Aim of study:

This study aims to redesign and measure patient satisfaction and treatment of the patient flow process. Based on ontology, it will redesign the core patient flow processes with the simultaneous introduction of a patient-oriented model that will conceptualise and implement this ontological framework.

5.3 Primary outcome (s)

Outcome measure(s)	Time-point
A novel redesign of core transactions of the patient flow process, based on ontology, and its supporting patient-oriented information system, from being healthcare oriented to being patient oriented	2010
Implement this study's conceptualisation (patient-oriented flow) in a novel beyond any doubt, way through the function of the supporting information system as well as its measures used for the ontological process redesign	2009
Improve efficiency in the healthcare system through competent management of institutional resources by providing a fertile framework for strategic cooperation among patients and healthcare providers.	N/A

5.4 Secondary outcome (s)

Assist in the development and maintenance of measurable activity-based driven results that improve patient quality value added services, turning everyday healthcare acts into healthcare facts relevant to this study's concept.

5.5 In what way will the research contribute to knowledge or healthcare development?

Scientific contributions of this study, besides its novel framework include the discovery and redesign of the contemporary both conceptual and model gaps in the patient flow process, the introduction of a scientific and not practical redesign through the enterprise ontology methodology and the functional design measuring objectively and proactively through leading measures this framework. Finally the implementation of a novel patient-oriented framework (OS) based on universal characteristics.

6. Study subjects

6.1 Inclusion criteria:

Patient oriented transactions, results and measures towards satisfaction

6.2 Exclusion criteria:

Patient treatment

6.3 Sample-size and rationale for calculation:

Sample-size = 9 Based on the following rationale:

6.3 Number of subjects to be recruited locally in relation to this application:

n = 9 in applying site.

6.4 How will subjects be identified and recruited?

N/A

7. Study Design:

Retrospective and Questionnaire Survey

8. Methods of Statistical Analysis

Both CDA and EDA

9. Confidentiality and Use of Results

How will data be handled and stored during and after completion of the study, and who will be responsible for its safekeeping?

THE INVESTIGATOR/RESEARCHER

Who will have access to the data or study record during or after the study?

HEALTHCARE INFORMATICS DEPARTMENT. CITY UNIVERSITY. LONDON

How long will the data be kept and what will be done with them after completion of storage period?

THE INVESTIGATOR/RESEARCHER

10. Declaration by Investigators

Scientific Title of Study:

NATIONAL PATIENT FLOW FRAMEWORK: AN ONTOLOGICAL PATIENT-ORIENTED REDESIGN

1. I/We declare that the information supplied is to the best of our knowledge and accurate.
2. I/We agree to uphold the protection of research subjects' rights and safety through adherence to local laws, Declaration of Helsiniki, institutional polices and ICH-GCP.

	Title and Name	Signature	Date
Principal investigator	PAPAGIANNIS, AKIS, FRAGOULIS		15/04/2008
For student project:			
Academic supervisor	ROUDSARI ABDUL		15/04/2008

Endorsement of Respondents

Scientific Title of Study:

NATIONAL PATIENT FLOW FRAMEWORK: AN ONTOLOGICAL PATIENT-ORIENTED REDESIGN

1. **I endorse the application and authorize the captioned study to be undertaken.**

Signature	Name	Post, Dept, Institution/Hospital	Date

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