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Operational Risk Management Healthcare Portugal – Pre Covid19

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Abstract

The main purpose of this study was cheking if there is a cause-effect relation between the finance effort and healthcare outputs in Portuguese Public Hospitals. This cause-effect relation will be checked from the operational risk prespective in the context of specific, comparable and fair data that allow relate traditional and new operacional risk proxies with healthcare outputs.

We conclude that there is no operational risk concept for public Portuguese healthcare, thus using efficiency as operational risk proxy, there is not possible to stablish a rational relation between finance effort and healthcare outputs in Portuguese Public Hospitals.

We also conclude there is no fit and proper transparency in Portuguese Public Hospitals financial statements and the disclosure is not prompt and accurate, taking in consideration, only, minimal requirements.

In this context the current status doesn´t assure proper managment in Portuguese Public Hospitals, where the board of administration staff nomination is based essencially in irrational (politics) criterea.

This situation result that the cirurghical wating times are very high for all the specialities so there is no equity in healthcare acess in Portugal since the population that can afford a private health insurance have a better acess that the other.

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List of Acronyms

ACSS	Central Administration of the Health System
AP	All patient
ARS	Regional Health Administration
DEA	Data Envelopment Analyses
DRS	Diagnosis Related Groups
EBITDA	Earnings before interest, taxes, depreciation and amortisation
EPE	Public Business Entities
EPER	Reclassified Public Business Entities
ERM	Enterprise Risk Management
DRG	Homogeneous Diagnostic Groups
ICD	International Classification of Diseases
INE	National Institute of Statistics
KPI	Key Performance Indicators
MCDT	Complementary Means of Diagnosis and Therapy
NPM	New Public Management
NHS	National Health System
NHI	National Health Insurance
OECD	Organisation for Economic Co-operation and Development
PPP	Public-Private Partnerships
GDP	Gross Domestic Product
SA	Public Limited Company
SPMS	Shared Services of the Ministry of Health
SNS	National Health System
SFA	Stochastic Frontier Analysis
ICU	Intensive Care Unit
VAR	Value at Risk
VFM	Value for Money
WHO	World Health Organisation

Chapter 1 - Introduction

1.1. **Research topic**

The aim of this study is to assess whether there is a cause-and-effect relationship between the financial resources consumed by non-financial public companies in the health sector and their healthcare results.

The aim is to analyse all the hospitals EPE from the point of view of operational risk, and to try to verify, within reasonable areas of comparability, how traditional and non-traditional operational risk indicators (co)relate to the entities' healthcare performance.

It is also intended that this study will contribute to understanding whether or not there is a "value for money" rationale in such an important area for Portugal, and whether the strategy, if it exists, is more focused on the interests of the People, as financiers and potential users, or on corporate interests, which are clearly more focused on defending the professional classes they represent, than on the purpose of the Health Sector in Portugal.

Based on the above cognitive iterative, we will try to present an operational risk management model that can be implemented universally in care centres.

The Institute of Risk Management (2016) identifies risk management as an essential process for strategic management:

Risk management is a central component of any organisation's strategy and represents the process by which organisations identify a methodology for associating risk with the various activities they carry out, with the aim of achieving a sustained benefit in each activity, but across the entire portfolio of activities.

In the case of banking and insurance, as advocated by Basel III (2011) and Solvency II (2009), there are mathematical models for systematically framing risk management in a formula that can be standardised or an internal model that has to be validated beforehand by two structures of the state's indirect administration with the task of supervising the sector, namely the Insurance and Pension Funds Supervisory Authority and the Bank of Portugal.

The aim of these models will be to clearly identify all the risks underlying their activities in order to properly frame their strategic management. Operational risk is probably the most relevant for all organisations, due to its cross-cutting nature, and the

respective risk module is considered independently in the Basel III (2011) and Solvency II (2009) models mentioned above.

In financial management, risk is a concept that is associated with the loss resulting from an investment. Together with this concept, the concept of profitability is also analysed, and in the context of analysing financial equilibrium, reference is made to the relationship between both concepts.

In this sense, operational risk is associated with the possibility of losses resulting from the absence of inadequate or deficient procedures, systems or organisational policies, which due to their absence or existence result in, allow or facilitate errors, systems failures or any event with a materially relevant impact, from the point of view of the operating result, originating in the company's business processes.

Therefore, based on the most developed models in this area, which are commonly used in banking and insurance, the aim of this work was to idealise an evolution of these models into a model that could be used in the health sector.

This option will be even more evident when contextualised in the "industry 4.0" environment where all the robotisation processes underlying operational activity are based on an operational risk model and the systematisation of processes and procedures is an inevitability. This reality is already evident through the use of solutions such as IBM Watson.

According to the Bank of Portugal (2015) Operational Risk Management refers to a complete, continuous and systematic process of identifying, analysing, responding to, reporting and monitoring the respective risk.

Carvalho das Neves (2000) tells us that the income statement is the basic support for analysing operational and financial risk. The basic method for assessing operational risk involves trying to quantify the volatility of operating results. Similarly, the method for assessing financial risk using information from the income statement seeks to quantify the volatility of net income caused by the company's degree of indebtedness. The combination of the two volatility indicators results in a combined risk indicator. It is therefore easy to see that there are substantial differences in the ways in which risk is grouped, its designations and inherent concepts.

For most analysts, operational risk refers to the probability of (future) losses as a result of events that will cause changes in operating results. This is a financial or accounting-based definition, centred on the income statement and its division into:

- Operational area (day-to-day operations);
- Extraordinary area (in relation to exploitation);
- Financial area.

Of course, the balance sheet could show significant risks associated with financial imbalance which, in an extreme situation, could lead to a risk of insolvency.

There are sometimes significant differences in the understanding/definition of some concepts associated with risk. In the banking sector, and following Basel III (2011), operational risk is the probability of losses resulting, for example, from internal processes, people and systems, or external events. In this context, a classification/systematisation of this risk according to various types of events has been published:

- Internal fraud;
- External fraud and security in the workplace;
- Customers, products and business practices;
- Damage to physical assets;
- Business interruption and system failures;
- Execution, delivery and process management.

According to Breia, Mata and Pereira (2014) and based on current practice and terminology, both in financial and accounting terms, we will consider a generic concept of risk, associated with the possibility of significant variations in future cash flows (one of the methodologies used to identify impairments for some assets is based on a variant of this concept).

To summarise, we propose the following subdivisions for business risk:

- Economic risk: exogenous conditioning factors, macroeconomic framework and sectoral framework;
- Operational risk - conditions linked to the structure of the company's organisation and its resources.

Based on the last systematically, globally and transparently available information on the subject, provided by the Directorate-General for Treasury and Finance in 2014, the nominal value of the state's global portfolio of holdings in health represented a volume of corporate capital of around 2,273 Bio Euros, approximately 17 per cent of the total of non-financial public companies; in 2017 it represents 3,326 Bio Euros, or 13.5 per cent of the total.

Within this global portfolio, there are thirty-nine care providers, commonly known as hospital centres, hospitals, institutes and local health units, henceforth "Hospitals".

Thus, this work will be approached with the concept of Operational Risk Management as its conceptual premise, in relation to the State's portfolio of holdings in "Hospitals", currently public corporate entities (henceforth EPE).

As part of their study on the future of the healthcare system, Sakkelarides, Reis, Escoval, Conceição and Barbosa (2015) point out the following common challenges:

- Difficulties in improving the management models used in public administration, in view of the impact on the integrated health strategy;
- The recent tendency to diversify activity through the use of public-private partnerships in the health area;
- The slow pace of reform implementation;
- The ageing population.

1.2. Research questions

Even today, there is still a discussion, possibly innocuous, about the best way to approach the legal nature of "Hospitals", namely whether these entities should be set up as public limited companies or as EPEs.

This essentially political question sheds light not only on the consensus on what the National Health Service (henceforth SNS) should be, but also on what organisational structure the SNS should have, and whether the public sphere has the financial resources for sustainability in the medium to long term.

This issue arises at a time when, according to data released by the INE and Pordata, an imbalance in the natural balance is becoming evident in Portugal, which is beginning to

show a change in the population's age pyramid, now the working population, which is a central element in the financing of the SNS.

At the same time, the unprecedented development of scientific research, a context to which this thesis naturally intends to make a humble contribution, provides us with a set of solutions which, both from the point of view of the social sciences and from the point of view of the exact sciences, determine the possibility of making organisational management mechanisms evolve, as well as the mechanisms available to healthcare organisations that allow, for example, a significant increase in average life expectancy, which results in an increase in costs related to health innovation which, in the current paradigm, will only be universally accessible if the conditions of economic and financial sustainability are met to deal with this reality.

According to FARE (1994), hospitals are complex units that produce multiple outputs by using multiple inputs. In addition to their complexity, there are essential questions regarding their performance, namely how efficiently the resources involved in their operation are utilised. It is estimated that around half of the resources applied in the health sector relate to the operation of hospitals.

New public management originated, and developed significantly, in the Anglo-Saxon countries. This wave of reform, which has already been implemented consistently in some countries, has had a particularly significant impact on increasing the economy, efficiency and effectiveness of the health sector, with the national health service (NHS) in the United Kingdom being the most relevant and successful example of this reform of the sector.

According to Gonçalves (2008), the experience of the SA Hospitals in Portugal has seen an improvement in the technical efficiency frontier.

By means of Order No. 9567/2013, His Excellency the Assistant Secretary of State for Health decided to set up a working group to define a proposed methodology for integrating levels of healthcare for mainland Portugal.

After carrying out this work, Lopes, Carlos, Rodrigues, Mestre, Santana, Matias, Ribeiro (2014) highlighted three essential aspects:

- The importance of the subject, given the future developments that are expected in the characteristics of the supply of and demand for health care, and knowing that the rationale for integration is based on the fact that better coordination and interconnection

between the different functional units will make it possible to achieve better health results for the populations in a given geo-demographic context;

- The relatively broad scope that can be found in the debate on this issue, and in this work we have used the definition of the World Health Organisation, which in 2008 understood integration as forms of cooperation in the provision and guarantee of continuity of care for users of the national health service, with a view to maximising efficiency in responses and the best health outcomes;

- Approaching the integration of healthcare through dimensions facilitates the taxonomic ordering of the topic, making it possible to identify the key processes in each of the dimensions. The main ones can be considered: clinical, information, financial, administrative, normative and systemic.

As the SNS is a system that has "hospitals" as its central element, this study will look at the potential for optimisation through the centralisation of care, particularly in terms of primary and long-term care, as well as the organisational model.

In this sense, it could add value to analyse operational risk management in "Hospitals" through a holistic approach, taking into account the organisational model used, in order to try to identify the most favourable optimisation ratio between financial resources / care results, with the concept of value for money applicable to the NHS as a conceptual assumption.

I. *Justification with the framework*

Appropriate operational risk management can help to improve the management of "Hospitals" by optimising the resources used and thereby freeing up financial flows to improve their care outputs.

In this way, the framework addresses aspects of the current context of the SNS as a complex system that is essential for social cohesion, within a particular socio-economic framework that is expected to become more unfavourable not only due to expected demographic changes, but also due to the increase in financial needs to guarantee access to health innovation.

II. *Research Starting Question*

Is there an operational risk management concept for healthcare in Portugal?

III. *Derived Questions*

- Is there a cause-effect relationship between the financial resources consumed by the EPE "Hospitals" and the healthcare results obtained?
- Is information on operational and healthcare results disclosed transparently?
- Is the top management in a position to manage the "Hospitals" properly?
- Is the fairness of care real?

IV. *Research Subject and Objectives*

- Construction of a theoretical conceptual model on the relationship between care outcomes and financial resources consumed;
- Define an operational risk model to be used consistently throughout the universe under analysis;
- Construction of an explanatory model between key risk indicators and care outputs;
- Conclude on the efficiency between available resources and results obtained;
- Formalisation of an operational risk model that can be used in the health sector.

The aim of this work will be to build and formalise a theoretical conceptual model on the relationship between care outcomes and resources, in particular the financial resources used.

This theoretical conceptual model could be an operational risk management model, applied to the health sector, which will hopefully provide, in a more or less relative way, answers to the questions posed above, which this work will try to answer through this model.

1.3. Dissertation Structure

This dissertation will be based on nine chapters systematised as follows:

Part I: Introduction

Chapter 1

Part II: Literature Review

Chapter 2 to Chapter 5

Part III: Methodology

Chapter 6 to Chapter 7

Part IV: Results

Chapter 8

Part V: Results

Chapter 9

Chapter 2 - Health Management Models

2.1. Introduction

Law 56/79 of 15 September created the National Health Service, within the Ministry of Social Affairs, as an instrument of the state to ensure the right to health protection, under the terms of the Constitution. Access is guaranteed to all citizens, regardless of their economic and social status, as well as to foreigners on a reciprocal basis, stateless persons and political refugees.

The SNS involves all integrated health care, including health promotion and surveillance, disease prevention, diagnosis and treatment of patients and medical and social rehabilitation. It defines that access is free, but contemplates the possibility of creating user charges in order to rationalise the use of benefits.

This law establishes that the SNS enjoys administrative and financial autonomy and is structured in a decentralised and deconcentrated organisation, comprising central, regional and local bodies and with services providing primary health care (community health centres) and services providing specialised care (general hospitals, specialised hospitals and other specialised institutions).

Almost forty years ago, the state created the SNS as an instrument to operationalise its health policy and, from *the outset,* identified access for all, regardless of their economic status, as its primary objective, as well as the possibility of rationalising use through user charges.

Almost forty years on, this objective has clearly failed, given the sheer volume of waiting lists, which mean that those who can afford to access care do so, those who can't afford it don't and, sadly, not infrequently end up dying waiting for access...

The results in terms of access to care, visible in the size of the waiting lists, are therefore unequivocally a testament to the incompetence of the management model underlying all public hospitals, which is essentially based on a kind of corporate dictatorship where a vast group of professional groups totally focused on their particular interests, always justified by an alleged interest of third parties, not only repeat a set of fantastic alarmist *soundbites,* so typical of the media-driven world in which we live, but also try to hide in a more or less skilful way what, in view of the results, is all too

evident - the current management model is neither economical, nor efficient, nor effective.

It's not economical because it represents a very significant slice of the state budget, it's not efficient because the management model is not objectively focused on analysing the resources applied and the results obtained, and much less focused on taking corrective measures, nor is it effective, essentially because the strategy changes according to the colour of the social democracy of the moment, nevertheless, and in both cases, very creative in the proliferation of dependencies, hypocritical and voracious in the exacerbated consumption of public resources, but complex, because it confuses authority with authoritarianism and thus limits a priori, the implementation of a minimalist concept of *corporate governance*, *and* therefore limits a priori any management model that is intended to be established.

In this context and within a framework of collective alienation, where doctors and nurses give their opinions on management models, "managers" give their opinions on clinical protocols, and where professional associations compete on the glamour level of the location of their headquarters, corporations of lackeys are created that fight over the spoils of power, entertaining the dominant corporations, fencing arguments, usually fallacious and based on deep and solid ignorance, about the causes of problems without the slightest ability to find solutions.

In addition, corporate structures and organisational structures are not optimised and are the result of the creativity and arbitrariness of boards of directors appointed according to essentially political criteria, which tends to be irrational, where the power of the various corporations in the sector is felt, dedicated to maintaining *the status quo*, which results in "management" being handed over to "professionals" who, with or without relevant professional experience and/or adequate training and/or proven individual competence, perform key functions in the various EPE Hospitals, in a position of enormous intrinsic fragility, and therefore totally at the mercy of the dominant corporations and of the "concensual" support of almost all the interests in question ...

2.2. New Public Management

The concept of value for money is not a new concept, but it is an interesting one because it combines objectivity and subjectivity in a single concept. It's relatively

simple to understand the concept of cost as the actual outflow that someone has to pay in return for something, but when we compare cost with value we enter into the essence of the concept of value for money, which is absolutely crucial to the scope of this work.

According to Smith (2009) *"...The concept of value for money (VfM) has been central to health policy and the delivery of healthcare for some time. In its abstract form, the concept of VfM is straightforward: it represents the ratio of some measure of valued health system outputs to the associated expenditure, and few would argue that its pursuit is not a worthy goal.*

The main reasons for an interest in VfM relate to accountability: to reassure payers, in particular taxpayers, that their money is being spent wisely, and to reassure patients that their claims on the health system are being treated fairly and consistently."

The concept of *value for money* is associated with the concept of *new public management*, which refers to a set of reforms carried out in various countries around the world at the beginning of the 1980s, with the main focus on controlling costs and increasing efficiency.

According to Lane (2009) *"... New public management (NPM) is the theory of the most recent paradigm change in how the public sector is to be governed. Initiated in the United Kingdom, it spread to first and foremost the United States, Australia and especially New Zealand, and then further on to Scandinavia and Continental Europe. NPM is part of the managerial revolution that has gone around the world, affecting all countries, although to considerably different degrees. The theory of new public management contains the insights from game theory and from the disciplines of law and economics."*

The concept of *new public management* emerged in the face of the obvious weaknesses of the bureaucratic management model, the operationalisation of which materialised in the empirical concept of bureaucracy, no more than the translation of the principle of form over substance, so evident and latent in the functioning of the state's direct and indirect administration, as well as in some areas of the public business sector. This empirical concept of bureaucracy is characterised by inflexibility based on complex hierarchical systems, *top-down* decision-making schemes that result in the provision of services that are not client/user-centred.

Labri (1999) considers the following to be the main distinctive elements of *new public management:*

- decentralised management of public services through autonomous agencies with budgetary decentralisation and financial control;
- increasing use of markets and competition schemes in the provision of public services, through contractualisation abroad and other market mechanisms;
- growing emphasis on performance, outputs and customer orientation.

New public management derives from the "new institutional economics" movement, whose theoretical foundation is essentially based on the theories of public choice, transaction costs, agency theory and the theory of peudo-markets.

Public choice theory is a current of thought in public policy whose main focus is the total rejection of the traditional policy of continuous research into what is in the public interest. The various authors include Lindblom's incrementalism (1959), Braybrooke and Lindblom (1963) , Simon's rational model (1957) and Arrow's collective choice theory (1951), among others. The first authors of this theory argued that the motivation of a politician is similar to the motivation of a businessman, since their public policy proposals are based on motivations as particular as those of businessmen with a view to making a profit. In this sense, the objective function to be maximised by the politician is essentially the probabilistic function associated with their re-election, with a view to obtaining particular benefits such as power, economic gains, prestige and political ideals (Lane 1995).

This theory received a strong contribution from the work of James Buchana, who won the Nobel Prize for literature in 1986, and Tullok. In 1962, *"The Calculus of Consent"*, these authors addressed contractual and institutional relations for economic and political decision-making, in a context of the growing politicisation of the economy. Thus, predictably opportunistic behaviour translates into the defence of individual or corporate interests which, as a rule, do not coincide with the public interest.

This line of thinking inspired two politicians who became famous for *new public management* and the concept of *value for money, of* course, Margaret Tatcher in the United Kingdom and Ronald Regan in the United States.

However, this inspiration had its origins in a series of determining factors that led to a series of reforms carried out in these countries.

According to Labri (*1999), the following factors have emphasised new public management*:

Changes in the political context

The changes that took place in the political context were determining factors for the reformist impetus that took place in Western countries. In the United Kingdom, the ideas of the monetarist current found a favourable environment in the government of Margaret Tatcher, who came to power in 1979, and in the three subsequent governments. This set of reforms gave rise to strong social protest, visible through strong cultural reactions, in this respect I would highlight the *punk* movement, which was one of the various forms of social protest. However, in the context of new public management, the future showed that ... *yes there was future in England's dreaming.* In the United States, Regan's election in 1978 emphasised market-oriented reforms and public sector efficiency.

Information Technology

The existence of new technologies helped to create the conditions for the reform movement in public administration, since the existence of archaic information systems without the capacity to process and analyse massive volumes of information would not have facilitated the decentralisation of services.

Consultancy

According to the author above, the role of consultancies is considered relevant in the systematisation and dissemination of *"good practices" and* has facilitated the use in the public sector of some of the techniques originating in the private sector.

The combination of these factors favoured developments in public sector management models, which justified more or less far-reaching reforms in the economy.

2.3. Management models

There are no pre-defined, systematic, consistent and coherent management models for the public sector, and in the particular case of the public health business sector, the management model with the most similarities may be the human resources management model.

According to Ferlie *et al.* (1996), there are four different models for classifying the break with the traditional form of public administration:

- Model I - Focus on efficiency;
- Model II - Downsizing and decentralisation;
- Model III - Focus on excellence;
- Model IV - Orientation to public service.

Model I

This model was pioneering and emerged in the first half of the 1980s, at a time when attempts were being made to introduce private management models into public management in order to make organisations more efficient. Pollit C. (1990) caricatured this trend as neo-taylorism, as he considered that it imported private management models into the public administration in an inappropriate way.

This efficiency model is based on the following set of characteristics:

(i) A focus on financial control, efficiency gains, obtaining results, improving the effectiveness of resources, systematic use of more sophisticated information systems, allowing greater control over costs;

(ii) Changes to hierarchical operating models, favouring competence, based on the definition of clear and effectively monitored objectives;

(iii) Auditing and financial control methods, with a focus on the use of benchmarking with other organisations and the evaluation of individual performance;

(iv) Great concern for users' needs;

(v) Flexibility in labour relations, with less emphasis on the role of collective bargaining, negotiation of short-term individual employment contracts and a trend towards higher pay for senior managers with above-average performance;

(vi) Loss of power of professional and bureaucratic groups to the detriment of a new class of managers;

(vii) New forms of corporate governance where traditional representatives (trade unions) lose power and have no seat on governing bodies. The figure of the board of directors has also emerged as the highest management body within the organisation, similar to what happens in private companies.

The efficiency-focused model seeks to respond to the inefficiency, wastefulness, bureaucracy and poor performance of traditional public administration.

Model II

The main focus of this model is the inefficiency associated with large, vertically integrated organisations. For proponents of this model, organisations need to be restructured, streamlined, debureaucratised and segregated by activity, with greater organisational flexibility and decentralisation of strategic and budgetary decisions.

This model had its origins in company restructuring processes at the end of the 1970s, with the privatisation of companies that saw the segregation of activities, for example in the electricity and tobacco sectors.

We can summarise the aspects that characterise this model as follows:

- market orientation (some authors refer to pseudo-markets);
- changing the management model to a contractualisation concept;
- *outsourcing* of *non-core* functions;
- less hierarchical and therefore more flexible organisational structures;
- optimisation of the workforce;
- segregation between those who provide the service and those who finance it.

Model III

The main focus of this model is organisational excellence and its precursor was Tom Peters and Robert H Waterman Jr, who published *In Search of Excellence in* 1982. The model is based on the human relations school, which focuses on organisational culture and the role of values, culture and organisational *branding* as an aggregating element in the organisation *(Ferlie et.al, 1996).* This model is associated with humanistic and somewhat collectivist management models that focus on development based on the internal capabilities of the organisation's employees.

We can systematise the following elements that characterise this model:

- the strategy is clearly communicated, with a particular focus on the strategic component of the human resources function;
- organisational change is accompanied by customised training programmes and "sponsored" by concepts of charismatic leadership;

- the vision is thus projected from the top to the bottom of the organisation.
- a focus on decentralising responsibilities and assessing performance according to results;
- introducing organisational culture as a uniting element;
- focus on organisational development.

Model IV

This model is considered to be the least differentiated from the other *new public management* models above, and its potential has not yet been properly identified. This model includes a set of concepts from the public and private sectors, with the aim of providing a new concept of public service through public managers capable of implementing good private sector practices in the public sector. This model therefore introduces a new dimension to the public management *modus operandi of the* past, introducing new areas such as the public service mission within the framework of methods and approaches typical of the private sector *(Osborne et.al, 1992).* In this context, management accountability and the reporting of results to users and other *stakeholders* become essential and central elements of this model.

In this context, this model can be characterised by the following features:
- distinctive and differentiated public services, with a focus on participation and reporting results;
- focus on social learning and improving operational support processes, as an alternative to "*routine*" service provision;
- focus on the user/client, valorisation of the user/client experience and valorisation of citizenship and civic participation;
- concern for service quality (*total quality management*) with a view to providing excellent services.

In essence, models I, I and III attempt to use methods and techniques that are commonly used in the private sector and which therefore need to be properly adapted to the reality of public administration, its idiosyncrasies and a justified sense of impunity, associated with the elementary political dynamic of who elects, who chooses, who the public

"managers" are. The IV model appears to be more suitable for public management, but it also shows a theoretical framework that is still poorly supported.

Thus, despite the merits attributed to *new public management*, it is not unequivocally clear that the objectives defined a *priori* with the introduction of this concept have been fully or partially achieved.

A study was carried out on contractualisation and other forms of competition in developing countries and Batley (1996) concluded that the "preconception" that private sector intervention allows for higher levels of efficiency is only partially supported by the evidence. On the other hand, Barlett et al. (1994) point out that the quality of service provision tends to be minimised by the focus on economic aspects. In fact, from a "cost point of view", *new public management* favours the pursuit of efficiency, which translates into short-term gains, but it does not favour the "value point of view" that can be obtained by investing in the medium to long term in sectors such as education, health or the environment.

Despite ideological and budgetary constraints, health management models have been evolving in line not only with the evolution of other management models, but also through the development of *data analytics* models that make it possible, at all levels, to provide quantitative and qualitative information relevant to management.

In this regard, Badinelli and Sarno (2017) studied the impact of the internet and big data analytics on the healthcare decision-making process and concluded that three points were completely decisive for healthcare management:

-The asymmetrical effect of decisions;

-The effectiveness of forecasts based on *big data analytics*;

- Flexibility in training resources and scheduling assistance.

In this context, I would like to highlight the first theme, namely the asymmetric effect of decisions. Badinelli and Sarno state that *"... it is generally believed that the use of IoT and BDA for predictive modelling will enable a form of demand management that will benefit all participants in the service system. However, the use of these technologies is not a win-win proposition for the patient and the medical clinic. The use of IoT and BDA for predictive analytics in support of engagement decisions has asymmetric effects. Benefits that accrue to the patient do not transfer to the medical clinic, which, in turn, may find its costs increase as a result of the patient adopting decision strategy*

DS2 over the most common decision rule DS3...". They also point out that *"... the root cause of the inability of the medical clinic to capture benefits from the use of IoT and BDA stems from a fundamental charateristic of service systems - the inertia of the service system constrains the rate of change of capacity and inventory...".*

This study has busted some myths and clearly demonstrates the challenges underlying the identification and operationalisation of cost parameters that allow management to have clear ideas about the best approaches to adopt when managing their care units.

2.4. The English example

Given the similarities between the English and Portuguese national health services, we'll analyse the English example in some detail.

After the Conservative party came to power (May 1979), as well as the sequence of governments that followed, objective conditions were created to challenge the principles of social democracy (Farnham et al, 1993).

This "right-wing" or "neo-liberal agenda", as it is sometimes called, argued that privatising part of the public sector and introducing pseudo-markets in this area would create the conditions to make public administration more efficient. In this context, when it wasn't possible to privatise, the aim was to make the public sector operate according to the rules of any other business, and in this sense, private sector management models had to be transposed to the public sector.

This paradigm focused on the economy, with a particular focus on financial control, efficiency and effectiveness, and materialised in the creation of pseudo-markets.

With the *NHS and Community Care Act (1990)* public services had to be run as pseudo-businesses and there was a strong belief that this approach would bring a number of benefits, including quality, efficiency based on choice, accountability and fairness (Ferlie et al, 1996).

These pseudo-markets are not polarised markets, but rather markets with their own characteristics, where the buyers, typically contracting agencies, are in a process of continuous negotiation with the providers of care services.

There are many similarities between the NHS and the SNS, and to some extent the NHS has been a kind of *best practice* for our SNS. In both systems, resources come essentially from taxes, user charges have a minimal impact but are often discussed at the

highest level of political demagoguery, and most providers are public, under the assumption of universal coverage and "tending" to be free.

According to Enthoven (1991), some of the problems of the NHS before the reform were characterised by the great autonomy and power of the medical profession: long-term contracts implying less bargaining power on the part of the health authorities, the majority of workers being unionised and job security. These situations are essentially unchanged in Portugal in 2018.

After much scrutiny of NHS spending (White Paper, Working for Patients) the NHS and Community Care Act 1990 was produced and implemented in April 1991. It was following this legislative measure that the internal health market was introduced, which in fact represented the biggest organisational and management change in the history of the NHS.

It should be noted that the creation of pseudo-markets in healthcare was based on an attempt to reduce waiting lists in the 80s.

The creation of agencies was intended to replicate market conditions in the management and provision of public services, particularly in situations where privatisation is not possible or desirable. The aim of external contractualisation is to stimulate competition between service providers (hospitals, clinics, etc.) in the belief that competition will bring down costs, increase efficiency and broaden the range in terms of response capacity (Savas, 1990).

Within this framework, regional health authorities would be the buyers of care services, while hospitals, doctors and other service providers would compete to offer their services. Thus, the budget to be allocated to hospitals would depend on the services and production that they were able to put on the market, i.e. *the money follows the patient* principle.

Following the creation of the internal health market, a significant number of NHS hospitals were transformed into NHS *Hospital Trusts, i*.e. hospitals outside the sphere of government control and managed as autonomous units, but an integral part of the NHS.

In this new paradigm, the Trust Hospitals had to compete for contracts with regional contracting entities and had greater management autonomy, with responsibilities assigned to a board of directors made up of executive and non-executive directors.

The Trust Hospitals are part of a general context of decentralisation of care, more focused on the needs of patients, based on the connection and proximity between the Trust Hospitals and the local communities.

This new rationale for competition made it possible to focus more on the costs of running the system, but in many cases this situation also led to duplication of services, which was very visible in the areas of MCDTs, which led to an increase in transaction costs. This internal health market functioned for most of the 1990s as a mechanism for allocating resources in the NHS.

After the election of Tony Blair in 1997, the priorities of the NHS changed and we can identify the publication of the *White Paper - The New NHS* in December 1997 as a milestone prior to the strategic change that took place.

This *White Paper - The New NHS* - and other documents that followed, changed the rationale by placing an increasing focus on processes based on resource planning, compensation schemes and partnerships, and less focus on the pseudo-market conceptualised in the Tatcher governments.

Another significant change was the possibility for insurance companies to negotiate directly with hospitals, without the need to involve regional health authorities. This new autonomy for the Trusts implied greater responsibilities in obtaining external sources of funding and in the internal organisational strategy for contract management.

In the context of pseudo-markets, information systems have come to play a more important and crucial role in determining costs than the typical processes of central public administration, which are based on a bureaucratic approach.

According to Harrison et al (1992), the NHS has seen a shift from a vertically integrated bureaucratic structure typical of the post-war welfare state (in some ways imitating the Fordist corporation) to a post-Fordist model where the organisation is fragmented into a large number of operational units that are somehow coordinated by a central organisation. Control is no longer exercised through hierarchical command, but through a mixture of subcontracting and partnership agreements.

As a result, funders and purchasers of services have also become responsible for quality standards, planning services and guaranteeing contractualised performance. The evaluation of pseudo-markets in the health sector does not allow for firm conclusions

about the results obtained. For economists, in general, the most important aspect of the evaluation is the impact on the efficiency of the NHS.

According to Maynard (1993), the reforms have produced advantages and disadvantages (costs are skyrocketing) but the balance is still unknown. He argues that the reforms have not been properly evaluated and it is therefore impossible to determine whether or not there have been efficiency gains.

According to Barlett et al. (1994), they compared the cost structures before the reforms of the Trust hospitals with a group of non-Trust hospitals. Although the authors concluded that, in many areas, the costs of Trust hospitals were lower than those of non-Trusts, this does not seem to be a consequence of the reforms implemented but rather of a selection of the most efficient hospitals whose costs were already lower before the reforms.

According to Ferlie et al. (1996) *" in many areas, trusts had significantly lower costs than non-trusts. However, these differences could not be attributed to the reforms as the data were taken from the pre-reform period. Rather the results suggested that the first wave and to a lesser extent second-wave trusts were self-selecting high performers who were already among the most efficient providers"*

The question of comparability of results between health units, whether in the UK, Portugal or anywhere else in the world, is always a challenge and in a context of public systems, there can be a temptation for private companies operating as service providers - in Portugal PPP, in *England Trust hospitals - to* make adverse selections of patients.

Adverse patient selection essentially consists of "pushing" the most complex and expensive patients towards public providers, through "judicious" management of waiting lists, as well as exploiting the many weaknesses of public contracting agencies.

Even so, the tolerance of promiscuity associated with holding public office is also a cultural factor, and on this point there is clearly a very significant difference between Latin and British culture.

The Finnish system is a Beveridge-type health system in which funding is based on taxes, which is why it is also comparable to the Portuguese system.

According to Gross-Tebbe et al. (2005), the Finnish healthcare system has an interesting feature: it is very well received by the Finnish population. In fact, around 80 per cent are

satisfied with their healthcare system, a figure well above the European average of 41.3 per cent.

According to Hakkinen et al. (2002), since the late 1980s the Finnish healthcare system has seen attempts to reform its management in order to implement ideas from the *new public management*, such as management by objectives, process management, total quality management, *balanced scorecard* models and performance-based remuneration schemes.

Competition in healthcare in Finland has taken a different form from the UK experience. On the one hand, measures were implemented to separate the roles of purchaser (financier) of health services from those of provider. On the other hand, and as a differentiating aspect, health services were decentralised and municipalities took on these responsibilities. Health services were contracted out to the municipalities with a view to introducing competition and containing costs.

In the 1980s the trend towards decentralisation became more and more evident, but in the 1990s some structural changes were made to health and social services. In 1993, the state subsidy system was changed and responsibility for organising health services was transferred to the municipalities.

According to Gross-Tebbe et al. (2005) in 2002 around 43 per cent of health costs were financed by municipalities, 17 per cent by central government, 16 per cent by national health insurance and 24 per cent by private funding.

The economic crisis in Finland in the 1990s posed problems for municipalities, forcing them to make structural reforms and cut costs in order to cope with budget restrictions.

According to various indicators, health care in Finland has improved considerably in recent decades. Some of the most significant health problems are diseases of the circulatory system (they account for almost half of the causes of death in the population), malignant tumours and mental illness.

Hospital care, which was not sufficient in the first half of the 19th century, was given a strong boost in the 1950s when 20 central hospitals were built in the largest cities.

At the same time, with the exception of psychiatric hospitals, public hospitals were transferred to the municipalities. It should be noted that this issue is being debated in Portugal in 2018 ...

In the 1960s, district hospitals were built on the initiative of the municipalities and a nationwide health insurance system (*National Health Insurance-NHI*) was created to deal with the high health costs that the population had to bear. This decade also saw a significant increase in the number of doctors in training.

In the 1980s, health and social services were incorporated into the same planning and funding system, and a process of decentralisation began. This decade saw the introduction of the family doctor.

The deep economic crisis in the 1990s did not favour the Finnish healthcare system, but there was a strengthening of municipal autonomy and reforms in the healthcare administration services.

Finland is divided into 20 hospital districts, each of which is responsible for specialised medical care, each municipality belongs to a hospital district and, as a rule, a hospital district comprises 1 to 3 non-psychiatric hospitals and 1 to 2 psychiatric hospitals. On an annual basis, all municipalities negotiate services with their hospital district.

Another interesting feature is the existence of an adjustment mechanism that allows the risk of very high treatment costs to be shared between all the municipalities that are members of a given hospital district. This aspect is of great importance given the size, in population terms, of some municipalities, which, if the mechanism didn't exist, would cause significant disruption to their budgets.

Chapter 3 - The hospital network in Portugal

3.1. Demand and supply in health

According to Beresniak et al. (1999), the way in which supply and demand in the health sector are articulated is different from other sectors of the economy, because health is not consumed or exchanged, there is supply and demand for health care, and health is an ideal objective for which health care competes.

The demand for and supply of healthcare is strongly influenced by various factors, including financing systems, demographic and cultural factors.

Financing systems influence the supply of health care and, in the face of a universal system that tends to be free of charge, such as the Portuguese system, health insurance would, in theory, be absolutely unnecessary. However, given the public service's inability to respond, it is a valuable asset that, in complementarity with the public system, improves/enables access to care for its insured members.

Health insurance is built on the basis of a certain maximum ceiling, i.e. unlike other insurances, where only exclusions are defined but no maximum capital thresholds are set, hence the need for reinsurance, in the case of health insurance, the policyholder takes out a policy where they pay a premium in return for a set of pre-defined *ceilings.*

This situation results in a certain induction of demand for healthcare, given the notion that policyholders have the "right" to consume the *ceiling* that is available to them.

Many health systems in developed countries use social protection mechanisms where the state guarantees social insurance to cover the full risk of illness, thereby favouring increased consumption.

In Portugal, funding is supported directly and indirectly by the state. Directly through the SNS and indirectly through ADSE, a public health insurance scheme that covers all civil servants and their families and which, objectively, significantly finances the private health sector, hospitals and clinics.

The supply and demand system is also strongly influenced by demographic factors.

Analysing the Portuguese case, healthcare provision is located in the most developed and populous regions along the coast, following the trend of the country's territorial distribution. However, in addition to the above constraints, access is also not equitable between the coast and the interior, between large cities and small towns.

In addition, the demand for care is not evenly spread across the population, with the elderly and children seeking care more than the rest of the population.

Finally, cultural factors are also decisive in understanding the importance that individuals attach to health and well-being.

According to Beresniak et al. (1999), for the most disadvantaged social classes, certain types of illness do not even merit their attention. The difficult conditions of their way of life leave little room for manoeuvre when it comes to health issues, except when they become more serious.

For the more economically favoured social classes, progressive changes in their state of health are monitored more closely, sometimes using sophisticated diagnostic means. This is why consumption of outpatient healthcare is typically high in this social stratum, while hospitalisation costs are lower.

According to Grossman (1972) each individual has a production function that transforms inputs into health stock. These inputs are individuals' time and medical care. In fact, the consumption of goods and services can be interpreted as a productive or intermediate factor acquired to produce health, as well as the time that each person dedicates to producing health.

According to Folland et al (2001) the stock of health also depends on other factors such as education, age and salary.

For Grossman (1972), health can be seen as both a consumer good and an investment good. It is an investment good because investing in its stock reduces the number of days of inability to work, in other words, it reduces the number of days of illness. If you reach a stock level below a certain value, you enter an irreversible process that leads to death.

According to Barros (2005), it is up to each individual to make choices that affect their health stock: i) divide their time between work and leisure; ii) in relation to leisure time, allocate time for health production and other purposes; iii) divide income between intermediate goods for health production and pure consumer goods; iv) investment in health for the following period.

Barros (2005) also points out that, contrary to economic theory, the increase in the supply of health services does not lead, as might be expected, to competitive processes leading to lower prices. In fact, what is observed is that there is only a greater volume of

services on offer and an increase in the range of choices. One possible explanation for this phenomenon concerns the possible rigidity of price reductions, even when they are essentially salaries for health professionals.

Empirical studies raise some doubts about demand induction, particularly when they compare the reality between Europe and the United States, concluding that demand induction is lower in Europe as a result of a more assertive medical ethical culture, and that the phenomenon of demand induction does not occur in all types of medical care.

An example of the explicit inclusion of the ethical costs of inducing demand in economic analysis models is given by McGuirre and Pauly's (1991) model, which states that the doctor takes into account that greater induction of demand has benefits in terms of income, but has ethical costs associated directly with this induction and leisure time costs associated with the fact that more services require more working time.

According to Barros (2014), the characteristics that allow the exercise of demand induction refer almost directly to information problems, namely the asymmetry of information between the doctor and the patient. it is therefore natural to develop analyses of the motivations for the existence of demand induction based on informational problems. A study along these lines is due to Calcott (1999). The interesting aspect of this study is the explicit consideration of patients' decisions, in particular, if the latter anticipate the practice of demand inducement on the part of the doctor, they will voluntarily limit their search for healthcare as a way of avoiding such inducement. This effect gives rise to another concept, that of "impeded demand".

In an attempt to explain the rationale typically used by doctors to establish a target income, Evans (1974) put forward the idea that the doctor has a disutility as a result of inducing demand. Thus, when deciding how much demand induction to carry out, a doctor takes into account the marginal benefit (higher income) but also a marginal cost (lower utility). The work of McGuire and Pauly (1991) formalises this idea, presenting a model of medical behaviour that has a utility cost in carrying out demand induction. This model incorporates the absence of induction and the target income model as limit cases.

McGuire and Pauly's model demonstrates that it is possible for the inducement of demand to be limited, even if the doctor does not have a target income objective. Inducement is limited by two forces: the increasing marginal disutility of inducing

demand and the increasing marginal disutility of the amount of labour devoted to satisfying demand.

3.2. The healthcare network in Portugal

Based on the information available on the Health Portal, we can find a number of relevant facts about the evolution of the health system in Portugal.

Law 56/79 of 15 September created the National Health Service, within the Ministry of Social Affairs, as an instrument of the state to ensure the right to health protection, under the terms of the Constitution. Access is guaranteed to all citizens, regardless of their economic and social status, as well as to foreigners on a reciprocal basis, stateless persons and political refugees.

The SNS involves all integrated health care, including health promotion and surveillance, disease prevention, diagnosis and treatment of patients and medical and social rehabilitation. It defines that access is free, but contemplates the possibility of creating user charges in order to rationalise the use of benefits.

The law establishes that the SNS enjoys administrative and financial autonomy and is structured in a decentralised and deconcentrated organisation, comprising central, regional and local bodies and with services providing primary health care (community health centres) and services providing specialised care (general hospitals, specialised hospitals and other specialised institutions).

Between 1980 and 2009 we can highlight the following facts:

1981 - The nursing career was approved by Decree-Law no. 305/81, of 12 November, in an attempt to respond to situations of injustice created or aggravated by Decree no. 534/76, of 8 July, which had approved the nursing staff of the Ministry of Social Affairs, as well as to the technical and scientific progress that had taken place in the meantime and the reality of the country.

1982 - Decree-Law 357/82 of 6 September granted the SNS administrative and financial autonomy. Considering that the management of financial resources allocated to the health sector requires coordination and adequate distribution, while at the same time speeding up the processes of action, it is understood that the SNS, as the support for all the sector's activities, should be given administrative and financial autonomy. The Health Services Financial Management Department is responsible for managing the funds allocated to it overall. On the other hand, Decree-Law 254/82 of 29 June created the regional health care administrations (ARS), which succeeded the district health service administrations.

In the same year, the General Practitioner medical career was created by Decree-Law no. 310/82, of 3 August, which regulates medical careers (public health, general practice and hospital medicine). The general practitioner is understood as the professional qualified to provide primary care to individuals, families and defined populations, working in terms of generality and continuity of care, personalised relationships with those assisted and socio-medical information.

1983 - Decree-Law 344-A/83 of 25 July, approving the Organic Law of the IX Constitutional Government, creates the Ministry of Health. Autonomy is dictated by the importance of the sector, the volume of services, the infrastructures it integrates and the importance that citizens recognise in it.

Normative Order 97/83 of 22 April approved the Health Centre Regulations, giving rise to the "second generation health centres". Health centres emerged as integrated health units, taking into account the principles informing regionalisation and the careers of health professionals.

1984 - The creation of the Directorate-General for Primary Health Care, by Decree-Law no. 74-C/84, of 2 March, put an end to the social medical services of the Social Security Agency and marked the expansion of the SNS. It became the central body responsible for technical and regulatory guidance, direction and assessment of the activities of

regional, district and local bodies and services involved in primary health care. The general practitioner acquires the status of family doctor.

1986 - Decree-Law 57/86 of 20 March regulates the conditions for exercising the right of access to the National Health Service. The decree aims to establish a correct and rational distribution of the costs of the National Health Service, both by the so-called health subsystems and by all entities of any kind that, by law or contract, are responsible for paying for the care of certain citizens.

It also safeguards that, because official establishments do not aim to make a profit, the prices they charge should be as close as possible to actual costs. It also provides for charges aimed at moderating the demand for healthcare, thus preventing it from being used beyond what is reasonable.

1988 - Decree-Law no. 19/88, of 21 January, approves the hospital management law, reflecting the concerns arising from the increase in the weight of health expenditure in the state budget. It emphasised the need to introduce principles of a business nature, within the framework of integrating hospital activity into the country's economy. And if quality is the main principle of hospital management, the profitability of services becomes an important value in administration. Examples of this are the creation of annual and multi-annual plans for hospitals and the creation of responsibility centres as intermediate levels of administration.

Regulatory Decree no. 3/88 of 22 January then introduced substantial changes in the area of the hospital's bodies and overall operation, as well as in the structure of the services. Thus, as in other European countries, the competences of the management bodies were strengthened, the collegiate type of directorates were abandoned, the members of the management bodies were appointed by the supervisory body, the profile of the manager was drawn up for the role of chief executive, business management methods were introduced and supervisory controls were strengthened and multiplied.

1989 - In the 2nd Constitutional Revision, Article 64(2)(a) is amended, establishing that the right to health protection is realised through a national health service that is "universal and general and, taking into account the economic and social conditions of citizens, tends to be free of charge". This places the emphasis on the principle of social justice and rationalisation of resources.

1990 - Law no. 48/90 of 24 August approves the Basic Health Law. For the first time, health protection is seen not only as a right, but also as a joint responsibility of citizens, society and the state, in freedom to seek and provide care.

Public health is promoted and defended through the activities of the state and other public bodies, and civil society organisations may be associated with these activities. Health care is provided by state services and establishments or, under the supervision of the state, by other public bodies or by private organisations, whether non-profit or for-profit. To fulfil the right to health protection, the state acts through its own services, but also enters into agreements with private entities to provide care and supports and supervises other private activity in the health area.

Base XXXIV also provides that user charges may be levied to supplement the measures regulating the use of health services.

Population groups subject to greater risk and the most financially disadvantaged are exempt from these fees, which are revenue for the National Health Service.

Decree-Law no. 73/90 of 6 March approved the medical career regime. Doctors, along with other health technicians, are recognised for their technical-scientific preparation, functional specificity and autonomy, and are now a special body of civil servants. In terms of working arrangements, in addition to setting a working week equal to that of the majority of civil servants, the practice of exclusive dedication is permitted and encouraged, without conditions and with a possible extension of the working week. Postgraduate and pre-career medical training is no longer included in the careers diploma.

1991 - Decree-Law no. 437/91, of 8 November, approves the legal regime for nursing careers, with the aim of regulating the practice of the profession, guaranteeing the safeguarding of specific ethical rights and standards and the provision of quality nursing care to citizens. The law clarifies concepts, characterises nursing care, specifies the competence of professionals legally qualified to provide it and defines their responsibilities, rights and duties.

1992 - Decree-Law no. 54/92 of 11 April establishes the system of user charges for access to emergency services, consultations and complementary means of diagnosis and therapy on an outpatient basis, as well as their exemptions. It states that the revenue collected from the partial payment of the cost of medical acts will constitute revenue for the National Health Service, contributing to increasing the efficiency and quality of the services provided to all, especially those provided free of charge to the most disadvantaged. The law emphasises the principles of social justice that require people with higher incomes and who are not chronically ill or at risk to pay for part of the healthcare they receive, so that others who are more needy and unprotected don't have to pay at all.

Decree-Law no. 177/92 of 13 August establishes the system for providing medical assistance abroad to beneficiaries of the National Health Service, reducing its scope to highly specialised medical assistance which, due to a lack of technical or human resources, cannot be provided in the country. Proposals for travelling abroad from private institutions are excluded.

1993 - The new SNS statute is published by Decree-Law no. 11/93 of 15 January, which seeks to overcome the dichotomy - from a medical and organisational point of view - between primary care and differentiated care. The indivisibility of health and the need for careful management of resources led to the creation of integrated healthcare units, making it possible for personalised groups of health centres and hospitals to work together.

The growing demands of the population in terms of quality and promptness of response to their health needs require that resources be managed as closely as possible to their recipients. This led to the creation of health regions, run by administrations with enhanced competences and powers.

Flexibility in resource management also requires the adoption of special mechanisms for staff mobility and recruitment, such as encouraging competitive methods and practices.
Decree-Law no. 335/93, of 29 September, approves the Regulations of the Regional Health Administrations.

In the same year, the National Health Service user identification card was created by Decree-Law 198/95 of 29 July. With regard to private activity in the health sector, Decree-Law 13/93 of 15 January was published, regulating the licensing and supervision of private health units. This law will be repealed in 2009.

1998 - Decree-Law no. 97/98 of 18 April establishes the system for concluding the agreements referred to in base XLI of Law no. 48/90 of 24 August - the Basic Health Law. This regime was in force until 2013.

As part of the search for innovative solutions to identify health gains and increase user and professional satisfaction, the same year saw the creation of the experimental remuneration scheme for doctors in the general practice career, through Decree-Law no. 117/98 of 5 May. The aim is to consolidate and expand the reforms to the organisation of healthcare provision, through proper and fair recognition of the different qualitative and quantitative levels of performance of healthcare professionals.

The remuneration of doctors covered by this law includes a basic salary and variable components. These correspond to carrying out home care, extending the period of care coverage and carrying out surveillance activities in relation to vulnerable groups corresponding to pregnancy and the puerperium, children in the first year of life and family planning for women of childbearing age.

In the same year, Council of Ministers Resolution 140/98 of 4 December set out a series of measures for the development of health education, including the reinforcement of tutorial learning in the community, in health centres and hospitals, within the framework of a curricular restructuring of undergraduate medical courses, the reorganisation of the network of higher nursing and health technology schools, through their transfer to the Ministry of Education, and the reorganisation of nurse training, with the transition from general training to degree level.

1999 - Public health services are structured, which include the exercise of health authority powers as the state's duty to intervene in the defence of public health, disease prevention and health promotion. Decree-Law no. 286/99, of 27 July, which establishes the organisation of public health services, states that implementation is carried out at two levels: regional and local.

Decree-Law 374/99 of 18 September created integrated responsibility centres (IRCs) in National Health Service hospitals. The IRCs are organic middle management structures, grouping together homogeneous services and/or functional units. Deconcentration of decision-making, planning and control of resources aims to introduce a business component into the management of these units. The aim is to increase efficiency and improve accessibility by making professionals more involved and responsible for managing the resources at their disposal.

On 11 September of the same year, Normative Order no. 61/99 was published, creating health service contracting agencies. These agencies take over from the health service monitoring agencies created by Normative Order 46/97, emphasising the distinction between health care provision and financing. The contractualisation agencies are responsible for explaining health needs and defending the interests of citizens and society, with a view to ensuring the best use of public health resources and maximum efficiency and equity in the health care provided.

In 1999, the Local Health Systems (SLS) regime was established by Decree-Law 156/99 of 10 May. These are a set of resources articulated on the basis of complementarity and organised according to geographic-population criteria, which aim to facilitate social participation and which, together with health centres and hospitals, aim to promote health and rationalise the use of resources. The SLS are made up of health centres, hospitals and other services and institutions, both public and private, whether profit-making or not, with a direct or indirect role in the field of health in a given geographical area of a health region.

A new regime for the creation, organisation and operation of health centres was also established by Decree-Law 157/99 of 10 May. This created the so-called "third generation health centres", which are legal entities governed by public law, integrated into the National Health Service and endowed with technical, administrative and financial autonomy and their own assets, under the supervision and oversight of the Minister of Health. The existence of health centre associations is also envisaged.

Legislative activity related to health was also marked by the publication of various pieces of legislation related to the licensing of private health units, such as Decree-Law 492/99, of 17 November, for private units that use ionising radiation; Decree-Law 217/99, of 15 June, for private laboratories; Decree-Law 500/99, of 19 November, for Physical Medicine and Rehabilitation clinics; and Decree-Law 505/99, of 20 November, for private dialysis units.

2001 - Following on from the 1999 legislation on private healthcare units, Decree-Law no. 233/2001 of 25 August was published, laying down the rules for licensing dental practices.

2002 - With the approval of the new hospital management regime by Law 27/2002 of 8 November, profound changes were made to the Basic Health Law. A new hospital management model was adopted and defined, applicable to the hospitals that make up the healthcare network, and institutional expression was given to business-type management models (EPE).

Decree-Law 39/2002 of 26 February had already approved a new way of appointing the technical management bodies of hospitals and health centres, changed the composition of hospital technical councils and made it more flexible for hospitals to contract goods and services.

2003 - Decree-Law no. 60/2003 of 1 April creates the primary healthcare network. As well as guaranteeing its traditional specific mission of providing comprehensive health care to citizens, the network must also be set up and assume itself, in permanent articulation with hospital health care and long-term health care, as a fundamental partner in health promotion and disease prevention. This new network is also a key element in the management of acute and chronic health problems. It reflects the need for a new integrated network of health services where, in addition to the fundamental role of the state, private and social organisations can coexist, geared towards the concrete needs of citizens. Two years later, this law will be repealed, and Decree-Law 157/99 of 10 May will be reinstated.

Decree-Law 173/2003 of 1 August revised user charges with the aim of moderating, rationalising and regulating access to healthcare, reinforcing the principle of social justice in the National Health System.

In the same year, the Health Regulatory Entity was created by Decree-Law 309/2003 of 10 December, thus separating the state's role as regulator and supervisor from its roles as operator and financier.

2004 - Decree-Law no. 90/2004, of 20 April, establishes the system for reimbursing the price of medicines.

2005 - With the publication of Decree-Law 95/2005, of 7 June, the first EPE Hospitals were created, transforming the SA Hospitals (Sociedade Anónima) into State Public Companies and providing them with more instruments to promote the effectiveness and efficiency of NHS resources.

In order to improve users' access to non-prescription medicines, Decree-Law 134/2005 of 16 August was published, regulating the system for selling these products outside pharmacies.

2006 - Decree-Law 101/2006 of 6 June creates the National Network for Integrated Continuing Care, with the aim of responding to the progressive ageing of the population, the increase in average life expectancy and the growing prevalence of people with disabling chronic illnesses.

This year also saw the publication of Decree-Law 176/2006, of 30 August, which establishes the legal framework for marketing authorisations and their amendments, manufacture, import, export, marketing, labelling and information, advertising, pharmacovigilance and the use of medicines for human use and their inspection, including homeopathic medicines, radiopharmaceuticals and traditional herbal medicines.

2007 - The first family health units appear, giving shape to the reform of primary health care.

Decree-Law no. 298/2007 of 22 August establishes the legal framework for the organisation and operation of these units and the incentive scheme to be awarded to their members, with the aim of achieving health gains by focusing on accessibility, continuity and overall care.

2008 - Another important step was taken in the reform of primary health care, with the creation of groupings of health centres in the SNS, through Decree-Law 28/2008 of 22 February. The aim is to give stability to the organisation of primary healthcare provision, enabling rigorous and balanced management and improved access to healthcare.

2009 - By Law no. 33/2009, of 14 July, the Assembly of the Republic approves the right to be accompanied in emergency services, determining that this right must be enshrined in the regulations of the respective health institution, which must clearly and rigorously define its rules and conditions of application.

In pursuit of modernising the services provided to the population in terms of public health surveillance, Law no. 81/2009 of 21 August and Decree-Law no. 81/2009 of 2 April were also published, promoting the restructuring of the organisation of operational public health services at regional and local level, in conjunction with the organisation of regional health administrations and health centre groupings. On the horizon is the change in the population's health and disease profile in recent decades, due to the evolution of global environmental conditions, changes in lifestyles and globalisation, among others.

Decree-Law 279/2009 of 6 October introduced a new legal framework for the opening, modification and operation of private health service units, making procedures more agile and in line with administrative modernisation.

After 2010 we can highlight the following facts:

2011 - Ordinance 198/2011 of 18 May was approved with the aim of facilitating citizens' access to medicines and promoting electronic prescribing, with the dematerialisation of the entire administrative medicine circuit. The generalisation of electronic prescriptions is essential in order to increase the quality of prescriptions and increase the safety of the medicine circuit. Electronic prescribing also serves as an incentive for the effective computerisation of the health system, stimulating communication between professionals from different institutions and reducing the risk of error or confusion in prescribing. This measure also makes it possible to obtain more information about the medicine circuit, discouraging and combating fraud.

2012 - With the advent of the widespread use of computerised data, Law no. 5/2012, of 23 January, regulates the requirements for the processing of personal data for the

constitution of nationwide files containing health data, using information technology and within the framework of the SNS.

In May this year, the new User Portal will be launched, as part of the PDS - Health Data Platform project, developed by CIC - Comissão para Informatização Clínica (Commission for Clinical Computerisation) and SPMS - Serviços Partilhados do Ministério da Saúde, EPE (Shared Services of the Ministry of Health, EPE), which allows health records to be made by the user and the use of online services that already exist and will be made available, such as booking appointments (eAgenda) or confirming surgeries (SIGIC).

2013 - Decree-Law no. 139/2013 of 9 October approved the new legal framework for conventions. With a more flexible model from the point of view of procedures, it is now possible for agreements to have a regional or national scope and to be signed by means of a membership contract or after a specific contracting procedure, while exceptionally agreements covering an integrated and/or extended set of services may also be signed.

Decree-Law no. 138/2013, of 9 October, defines the ways in which the Ministry of Health and the establishments and services of the National Health Service (SNS) work together with private social solidarity institutions, as well as establishing the system for returning to the Misericórdias the hospitals that were the subject of the measures provided for in Decree-Laws no. 704/74, of 7 December, and no. 6/75, of 11 November.This recognises that the Misericórdias combine the technical demands of providing health care with their centuries-old vocation and tradition, non-profit status and proximity to the population, which makes them important partners for the state in the area of health.

2014 - Decree-Law 110/2014, of 10 July, creates the Health Research Fund within the Ministry of Health, with the aim of strengthening research activities to protect, promote and improve people's health and thus achieve health gains. Health research is considered instrumental in the continuous improvement of quality, the training of professionals and

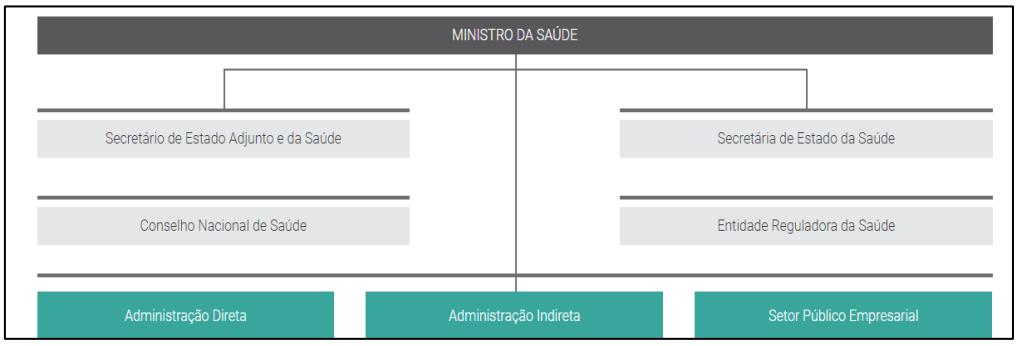
the international projection of the country in a highly competitive area, where the gains from the production of knowledge can be significant.
The principles and framework of the family nurse's activity within the functional units of primary health care are defined by Decree-Law no. 118/2014 of 5 August.

The measure aims to improve quality and citizens' effective access to healthcare and to re-evaluate the role of nurses. In this way, the importance of nursing's contribution to health promotion and disease prevention is reinforced and new challenges are set for nurses.

Law no. 52/2014 of 25 August establishes rules on access to cross-border healthcare and promotes cooperation on cross-border healthcare, transposing Directive no. 2011/24/EU of the European Parliament and of the Council of 9 March 2011 and Commission Implementing Directive no. 2012/52/EU of 20 December 2012.

The National Health Service includes all public services and organisations that provide healthcare. The member of the Government responsible for the health area exercises powers of supervision and oversight over all SNS services and establishments, regardless of their legal nature.

Figure 1: Ministry of Health organisational chart



Source: Health Portal

As can be seen in Figure 1, the central structure of the Ministry of Health, supported by Secretaries of State, is made up of two entities as well as a number of entities that operate under its Direct and Indirect Administration and Public Business Sector:

- National Health Council;
- Health Regulatory Authority

The National Health Council is an independent advisory body to the government, made up of 30 members, which will ensure the participation of the various scientific, social, cultural and economic forces in the search for broad consensus on health policy.

The Health Regulatory Authority (ERS) is an independent public body whose mission is to regulate the activity of healthcare establishments.
ERS's scope of regulation includes all healthcare establishments in mainland Portugal in the public, private and social sectors, with the exception of pharmacies. We supervise healthcare establishments with regard to the requirements for exercising the activity; rights of access to healthcare and other user rights; the legality and transparency of economic relations between the various operators; and competition in the healthcare sector.
It carries out various activities to regulate and supervise providers; dealing with complaints from users, providers and institutions; carrying out inspections and audits of healthcare providers' facilities; investigating situations that may jeopardise users' rights; conducting administrative offence proceedings and imposing sanctions; issuing instructions, recommendations and opinions; carrying out studies on the organisation of the healthcare system.

The Direct Administration of the Ministry of Health is made up of four entities:

- General Secretariat for Health;
- General Inspection of Health Activities;
- General Directorate of Health;
- Addictive Behaviours and Dependencies Intervention Service.

The General Secretariat for Health is an entity that provides services to the offices of the members of the Government in the Ministry of Health (MoH) and to most of the

Ministry's services and bodies in some support areas - technical-legal support and litigation, internal resource management, public procurement, documentation, information, communication and public relations - and will continue to focus on promoting and optimising resources and providing excellent services.

The General Inspection of Health Activities is the control body in all areas of healthcare provision, whether by the institutions, services and organisations of the Ministry of Health, or those under its supervision, or by private entities, natural or legal persons, whether profit-making or not.
It has regular supervisory and inspection powers (which have been centralised in it and were previously dispersed in different entities) and provides regular internal auditing services to all the institutions, services, establishments and bodies of the Ministry or under its supervision.

The General Directorate of Health is a central service of the Ministry of Health, part of the direct administration of the State, with administrative autonomy. As a reference body for all those who think and act in the field of health, its main areas of intervention focus on: Coordinating and developing Health Plans and Programmes; Coordinating and ensuring epidemiological surveillance; Analysing and disseminating health information; Regulating and guaranteeing quality in health; Managing Public Health emergencies;Supporting the exercise of the powers of the National Health Authority;Coordinating the activity of the Ministry of Health in the field of European and international relations;Monitoring the National Health Service Call Centre;Coordinating and monitoring the Subsystem for Performance Evaluation of the Public Administration Services of the Ministry of Health.

The Addictive Behaviours and Dependencies Intervention Service is a reference service in the area of addictive behaviours and dependencies, guaranteeing the development of coherent and consistent policies and interventions, based on a strong technical normative component, guiding the practices developed by public and private stakeholders with operational responsibilities.

With the full assumption of responsibilities in terms of planning and monitoring programmes to reduce the consumption of psychoactive substances and other addictive behaviours and dependencies, the Service for Intervention in Addictive Behaviours and Dependencies is asserting itself every day, with confidence, knowledge and determination, within the organisational framework dedicated to reducing addictive behaviours and dependencies, gradually gaining skills and knowledge in new areas of action, namely in the field of non-substance dependencies.

The Indirect Administration of the Ministry of Health is made up of eleven entities and the Hospitals of the Public Administrative Sector:

- The Central Administration of the Health System;
- INFARMED, the national authority for medicines and health products, IP;
- The National Institute of Medical Emergency, IP;
- The Portuguese Institute of Blood and Transplantation, IP;
- The Instituto Nacional de Saúde Doutor Ricardo Jorge, IP;
- ADSE, the Institute for Health Protection and Assistance, IP;
- The Regional Health Administrations (North, Centre, Lisbon and V. Tejo, Alentejo and Algarve), IP.

The main responsibilities of the Central Administration of the Health System are: Planning and coordinating the financial resources of the SNS, Developing human resources policies in the health sector, including professional regulation, Defining financing models for the contracting of health care and monitoring the implementation of programme contracts with SNS hospitals, Coordinating the management of health facilities and equipment in the SNS, with a view to integrated organisation and rationalisation of the hospital network, primary health care, the National Network for Integrated Continuing Care, including mental health and the National Network for Palliative Care, Provide the SNS with adequate information and communication systems and mechanisms for rationalising purchases, through the SPMS, Coordinate and centralise the preparation of information and statistics on production, care performance, financial and human resources in the SNS, Managing the SNS Control

and Monitoring Centre, Managing the Integrated System for Managing Access to Health Care in the SNS, Promoting shared management of resources in the SNS, National contact point for Cross-Border Health Care, Preparing the implementation of the Public Health Initiatives Programme (EEA Grants).

INFARMED, the national authority for medicines and health products, IP;provides and receives co-operation from the services and bodies of the State's direct, indirect or autonomous administration, within the scope of its duties. Within the scope of its remit, INFARMED I.P. may, under the terms of the law, establish partnerships or join forces with other public or private sector organisations, whether profit-making or not, namely business associations, universities or institutions and services integrated into the National Health Service.

As a result of the publication of the new organic law, INFARMED, I.P. acquired new powers to authorise the retail price of prescription and non-prescription medicines that are reimbursed, by transferring powers in this area from the Ministry of Economy to the Ministry of Health.

At European Union level, it is a member of and participates in the committees, commissions and working groups of the Council of the European Union, the European Commission and the European Medicines Agency, promoting initiatives within the framework of the European System for the Evaluation and Supervision of Medicinal Products and Health Products, the European Network of Medicines and Health Products Authorities and the Network of Official Medicines Quality Assurance Laboratories in Europe.

The Portuguese Institute of Blood and Transplantation's remit is to propose measures of a political or legislative nature in matters related to its remit and to participate in the overall strategic definition of the development of transfusion medicine and transplantation; to coordinate, at national level, the collection, analysis, processing and transfusion of blood, as well as the collection, analysis, processing and transplantation of organs, tissues and cells of human origin; to ensure the operation of the National

Haemovigilance System and the National Biovigilance System, in conjunction with the competent national and international bodies; promote and support research in the fields of science and technology in the areas of transfusion medicine, transplantation and regenerative medicine, in conjunction with the Instituto Nacional de Saúde Doutor Ricardo Jorge and other national and international institutions considered strategic for the proposed objectives; promote the donation of blood, cells, tissues and organs in pursuit of national self-sufficiency; establish, maintain a register and monitor the activity of blood services, tissue and cell handling services and organ procurement; ensure international representation, in the field of its specific competences and attributions, without prejudice to the competences of the Ministry of Foreign Affairs, in conjunction with the Directorate-General for Health, as the entity responsible for coordinating the international relations of the Ministry of Health; ensuring that laboratory studies are carried out on patients required for the transplantation of organs, tissues and cells; maintaining and managing the Public Umbilical Cord Blood Bank (LUSOCORD); maintaining and managing the activity of the multi-tissue bank, including collection, analysis, processing, storage, distribution, import and export, defining national needs; ensuring the availability of human blood, blood components, organs, tissues and cells of human origin, meeting national needs; authorising the import and export of human blood, blood components, organs, tissues and cells of human origin, in conjunction with the Directorate-General for Health in terms of quality and safety; maintaining the National Centre for Peripheral Blood or Umbilical Cord Bone Marrow Stem Cell Donors (CEDACE); maintaining and managing a single, integrated information system for managing the waiting list of patients who are candidates for transplantation, the selection of the recipient donor pair for transplantation, the tissue bank and traceability.

The main duties of the Instituto Nacional de Saúde Doutor Ricardo Jorge are to promote and develop scientific research geared towards public health needs, carrying out the scientific, operational and financial management of research programmes in the public health sector; to promote the training of researchers and technicians, as well as carrying out actions to disseminate scientific culture, from a health in all policies perspective; promoting, organising and coordinating evaluation programmes, within the

scope of its duties, namely the external evaluation of laboratory quality and collaborating in the evaluation of the installation and operation of laboratories working in the health sector; promoting, organising and coordinating health observation programmes, namely environmental and biological monitoring studies (biosurveillance) of potentially toxic substances, with a view to evaluating the exposure of the population or specific population groups to these substances, carried out for the purposes of developing disease prevention and control plans; providing technical and regulatory support to public health laboratories; providing differentiated assistance in medical genetics for prevention and diagnosis, in laboratory services; planning and implementing the national early diagnosis programme; collaborating in epidemiological surveillance activities for communicable and non-communicable diseases, and developing or validating health observation tools, namely through laboratory data, within the scope of information systems, namely ensuring the production and dissemination of public health statistics, and promoting the necessary technical studies, without prejudice to the duties of the Directorate-General for Health and the Central Administration of the Health System in this area; ensuring the laboratory response in the event of a biological emergency of natural, accidental or deliberate origin, without prejudice to the coordination of the Directorate-General for Health in terms of the appropriate response to public health emergencies; monitoring the consumption of additives and the exposure of the population to contaminants and other potentially harmful substances present in food, including food ingredients whose level of ingestion may jeopardise the health of consumers; ensure the collection, compilation and transmission to the Directorate-General for Agriculture and Veterinary Science for the purposes of communication to the European Food Safety Authority of analytical data on the composition, including contaminants and other chemical substances, of foodstuffs and animal feed; evaluate the implementation and results of the Ministry of Health's policies, National Health Plan and health programmes; develop national and international cooperation actions, of a bilateral or multilateral nature, within the scope of its duties, without prejudice to the Ministry of Foreign Affairs' own competences, in conjunction with the Directorate-General for Health as the entity responsible for coordinating the Ministry of Health's international relations; provide paid services, namely scientific and technical advice, to public, private and social sector organisations,

at national and international level, in the areas of its remit; establish scientific prizes and grants for R&D activities, as an incentive to scientific and technical training; ensure the management and promotion of the Health Museum.

ADSE's main duties are to organise, implement, manage and control the system of health benefits for its beneficiaries; to enter into agreements, conventions, contracts and protocols that are relevant to the performance of its mission and to monitor compliance with them; to administer revenue in compliance with the principle of good administration; develop and implement control mechanisms inherent in the granting of benefits; apply the sanctions provided for by law to beneficiaries when infringements of ADSE, IP rules and regulations are detected; manage the benefits to be applied in the field of social protection for its beneficiaries; develop and implement mechanisms to combat fraud.

The main tasks of the Regional Health Administrations (Norte, Centro, Lisboa e V. Tejo, Alentejo and Algarve) are to implement national health policy, in accordance with global and sectoral policies, with a view to rational planning and optimising resources; participate in the definition of intersectoral coordination planning measures, with the aim of improving healthcare provision; collaborate in the preparation of the National Health Plan and monitor its implementation at regional level; develop and promote activities in the field of public health, in order to guarantee the protection and promotion of the population's health; ensuring the implementation of local intervention programmes aimed at reducing the consumption of psychoactive substances, preventing addictive behaviour and reducing dependencies; developing, consolidating and participating in the management of the National Integrated Continued Care Network in accordance with the guidelines defined; ensuring the regional planning of human, financial and material resources, including the implementation of the necessary investment projects, of the institutions and services providing health care, supervising their allocation; drawing up, in line with the guidelines defined at national level, the facilities and equipment charter; allocating, in accordance with the guidelines defined by the Central Administration of the Health System, IP, financial resources to institutions and services providing health care that are part of or financed by the

National Health Service and to private or non-profit entities that provide health care or operate within the scope of local intervention programmes aimed at reducing the consumption of psychoactive substances, preventing addictive behaviour and reducing dependencies and the National Network for Integrated Continuing Care; conclude, monitor and review contracts within the scope of public-private partnerships, in accordance with the guidelines defined by the Central Administration of the Health System, IP, and allocate the respective financial resources; negotiating, concluding and monitoring regional contracts, protocols and agreements in accordance with the guidelines defined at national level, as well as carrying out the respective evaluation and review, within the scope of healthcare provision, as well as in the areas of local intervention programmes aimed at reducing the consumption of psychoactive substances, preventing addictive behaviour and reducing dependencies, and the National Integrated Continued Care Network; guiding, providing technical support and evaluating the performance of healthcare institutions and services, in accordance with the policies defined and the guidelines and regulations issued by the central services and bodies responsible for the various areas of intervention; ensuring adequate coordination between healthcare services in order to guarantee compliance with the referral network; allocate financial resources by concluding, monitoring and reviewing contracts within the scope of integrated long-term care; draw up functional programmes for healthcare establishments; license private healthcare units and units in the area of addictions and addictive behaviours in the social and private sectors; issue opinions on master plans for healthcare units, as well as on the creation, modification and merger of services; issue opinions on the acquisition and expropriation of land and buildings for the installation of healthcare services, as well as on projects for healthcare providers' facilities; coordinate the management of the National Palliative Care Network at regional level, in accordance with the guidelines defined at national level.

The Public Business Sector and state-owned associations are made up of two entities: local health units, hospital centres and hospitals:

- Shared Services of the Ministry of Health (SPMS);
- Hospital Common Use Service (SUCH).

SPMS's main remit is to provide shared services specific to the health area in terms of purchasing and logistics, financial services, human resources and information and communication systems and technologies to the establishments and services of the National Health Service (SNS), regardless of their legal nature, as well as to the bodies and services of the Ministry of Health and any other entities, when they carry out activities specific to the health area; within the scope of procurement and logistics shared services, its mission is to centralise, optimise and rationalise the acquisition of goods and services and provide logistics services, with responsibilities in terms of procurement strategy, pre-contractual procedures, public procurement, internal logistics, payments and performance monitoring; within the scope of financial shared services, its mission is to co-operate, share knowledge and information and develop service provision activities in the areas of financial management and accounting, with responsibilities in terms of budget planning and preparation, budgetary control, contract management, analytical accounting, general accounting, payments and collections and treasury; within the scope of shared human resources services, its mission is to provide a shared human resources service with high efficiency and levels of automation, with responsibilities in terms of information gathering and diagnosis, salary processing and management indicators; within the scope of shared services for information and communication systems and technologies, its mission is to co-operate, share knowledge and information and develop service provision activities in the areas of information and communication systems and technologies, guaranteeing the operability and security of the Ministry of Health's technological infrastructures and information systems and promoting the definition and use of standards, methodologies and requirements that guarantee the interoperability and interconnection of health information systems with each other and with information systems across the Public Administration.

The SUCH is an instrument for self-satisfaction of the needs of its members and, to this end, is obliged to take on the initiatives that can contribute to a more agile and efficient operation, freeing them to dedicate themselves fully to the provision of healthcare to users and providing them with gains in scale, namely through the management and provision of technical assistance in the field of facilities and equipment; operating or

managing technical facilities and industrial areas, namely laundries, kitchens, power stations and transport; promoting actions in the field of technological development and research, both in terms of equipment and facilities, namely in terms of standardisation; collaborating in the training and professional development of staff as users of the equipment; carrying out most support services for the provision of healthcare.

In short, there are nineteen organisations upstream of hospital care units.

In the public business sector, the universe under which this work will be carried out, we can identify three distinct organisational models underlying hospitals:

- Hospital centres;
- Local health units;
- Hospitals.

To put it simply, hospital centres are characterised by a single management system shared by several hospitals, local health units are characterised by the integration of primary healthcare and hospital care under the same management system, and hospitals by a management system for one hospital. We have analysed all hospital centres, local health units and hospitals in this work and, despite some similarities, no two organisational models are the same.

Bearing in mind that the organisational charts are drawn up within the framework of the internal regulations of each hospital centre, local health unit or hospital, and that these internal regulations can be approved by the regional health administration of each region (North, Centre, Lisbon and Tagus Valley, Alentejo and Algarve), this situation clearly indicates that there is no coherent model of organisational structure from a formal point of view. For example, in the Algarve region, we find a paradigmatic concept that includes a regional health administration (for the Algarve) for just one hospital, the Algarve Hospital Centre.

Finally, given the vast, diverse and complex universe of all these sectoral entities, there is no *steering* model, nor is there a transparent, clear, unambiguous and objective model that clearly defines the responsibilities of each party, nor who, how, when and under

what circumstances each of the various entities should intervene. This situation, combined with the irrational/political components of management appointments, results in parasitic clientelism, the consequences of which have been visible for decades in the lack of economy, efficiency and effectiveness in the management of public healthcare in Portugal.

Chapter 4 - Hospital Production

4.1. Hospital Production

The concept of production refers to a notion of products and services that can be traded on the market for a certain price that reflects, in the context of an open economy, the value that the economy places on these products.

According to Smith et al (2007), the absence of prices that reflect true marginal social value is the fundamental characteristic of the non-tradable sector.

The fact that there are no prices for some services sometimes makes it difficult to value and define the associated production, but the significant weight that health represents in the state budget and in each country's GDP justifies trying to measure output in an accurate way to support the allocation of resources involved.

According to the national accounting practice in force between the 1960s and 1990s, the output of the public sector was essentially measured by the costs of the inputs used in the production process. This approach facilitated the operationalisation of accounting without implying a more complex and precise process of valuing production.

The main limitations of this praxis were that the value of outputs is the result of government cost choices, as outputs are not measured directly there are no productivity changes over time and decreases in expenditure due to technological improvements result, in this approach, in a reduction in output while the increase in efficiency happened at input level.

For these reasons, international organisations such as Eurostat and the United Nations recommend the use of measures that are independent of input costs, such as *Direct Volume Measurement.*

According to Eurostat (2011), in the health sector, the amount of care received by patients should be measured in terms of complete treatments.

According to Brathaug, Printchard (2006) et al one of the difficulties in implementing the definition of production (output) in the health sector lies in measuring complete treatments, as most patients receive a wide range of interventions from different healthcare providers at different times, so it is difficult to define when we can consider treatment to be finished.

These situations have a particular incidence on chronic patients, whose volume has been growing with the increase in average life expectancy, in a context with frequent users in a clinical setting of multipathologies, and therefore high associated direct costs.

Combining this with the increase in infectious diseases, the "classic" rationale where production and costs have a directly proportional relationship clearly doesn't hold true, because depending on the type of patient, fewer patients can mean more costs, if the type of patient implies a more complex/dangerous/frequent treatment regime.

In this context, the measurement of health outcomes should indicate the added value for health that results from contact with the health system, but given the difficulty of measuring output, the number of activities provided or the number of patients treated has been used as a reference, assigning a certain value based on the costs incurred in the care activity, as we will detail in point 4.2.

Until the end of 2002, payments made to hospitals in return for production were only made in return for financing costs, but after 2003, with the contractualisation of health services between regional administrations and hospitals, hospital production corresponds to sales of care services, which presupposes not only care activity, but also a set of national, regional and hospital-specific incentives based on a set of *key performance indicators*, which cover the essential aspects of hospital management from a macro perspective.

Quintela (2006) presents four methods for measuring hospital production:

- Method A, where production is calculated as the sum of production costs;

- Method B, where production results from the sale of healthcare;

- Method C corresponds to the model in force in Portugal, where in EPE hospitals production is measured by sales and in SPA hospitals production is calculated by the sum of costs;

- Method D, the care output is equal to the quantities multiplied by the average price or cost, and the quantities are obtained from homogeneous diagnosis groups (DRGs) determined by the hospitals. The output is valued by multiplying the DRG quantities by the respective price or cost.

Quintela concludes that Method D seems to be the best for measuring hospital production, being more stable in terms of results and not influenced by external factors, unlike the others.

Jacobs, Rowena (2006) *et al* presented a simplified efficiency model for health services, which considers the various inherent costs as inputs and the various components that make up hospital production as outputs.

Hospital production is based on the care provided in the following areas:

- Hospitalisation;
- Operating theatre;
- External consultations;
- Urgency;
- Day Hospital;
- Complementary Means of Diagnosis and Therapy (MCDT).

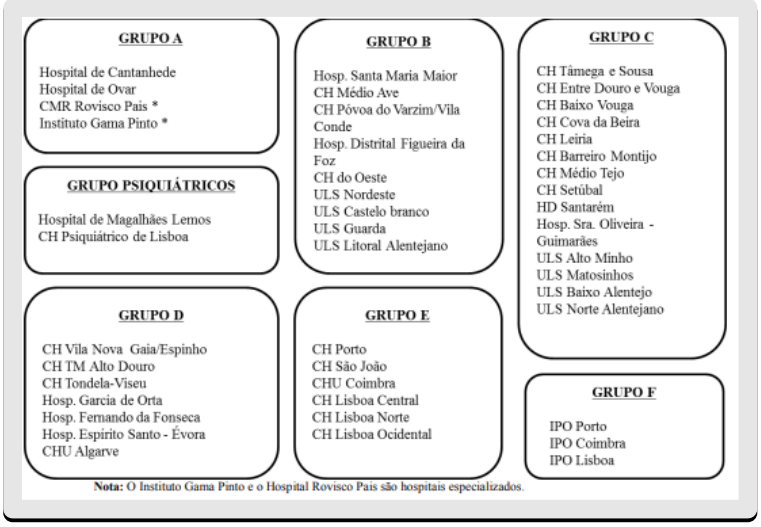
In Portugal, all activity carried out in operating theatres, inpatient wards and MCDTs is classified by coding doctors into homogeneous diagnostic groups (DRGs) and, depending on the DRG, the medical act is invoiced by the hospital to the regional health administration and then paid for by the central administration of the health system,

Outpatient, emergency and day hospital services are billed according to the number of episodes, multiplied by the list price established between the regional health administration and the hospital/hospital centre/local health unit.

In Portugal, hospitals are differentiated by their casemix index between "more complex" and "less complex" hospitals. The "more complex" hospitals are hospitals with more differentiated specialities and, as a rule, more care activity or care activity carried out in more differentiated areas, such as oncology, cardiology, vascular surgery or neurosurgery.

Thus, the "more complex" hospitals receive a higher unit value than the "less complex" hospitals. This kind of ranking is defined by the ACSS when it segregates hospitals into seven funding groups.

Figure 2: Hospital groups according to funding



Source: ACSS, terms of reference for health care contractualisation 2018.

This segregation, illustrated in the figure above, clearly shows the "less complex" hospitals in group A and the "more complex" hospitals in group F, and this segregation rationale is what influences the volume of funding for the healthcare activity carried out in these units.

There are also specific funding lines per patient, for patients with diseases that involve very high treatment costs, such as HIV or Hepatitis C.

4.2. Diagnosis Related Groups

The production of inpatient episodes is classified on the basis of Diagnosis Related Groups (DRGs) and involves the classification of all pathologies in order to determine whether the inpatient episode is predominantly medical or surgical.

According to the ACSS, Diagnosis Related Groups (DRGs) are a classification system for patients admitted to acute hospitals that groups patients into clinically coherent and similar groups from the point of view of resource consumption. It makes it possible to operationally define a hospital's products, which are nothing more than the set of goods and services that each patient receives depending on their needs and the pathology that led to their hospitalisation and as part of the defined treatment process.

Each group is associated with a relative weight, i.e. a weighting coefficient that reflects the expected cost of treating a typical patient grouped in that DRG, expressed in relative terms to the average cost of a typical patient at national level. A hospital's case-mix index is therefore the ratio between the number of equivalent patients weighted by the relative weights of the respective DRGs and the total number of equivalent patients.

The DRG patient classification system was originally designed in the late 1960s and early 1970s by a team from Yale University led by Professor Robert B. Fetter, an industrial engineer. The first objective was to classify patients into relatively homogeneous groups from the point of view of clinical characteristics and the associated consumption of resources, in order to make it possible to identify outliers. Since 1983, it has formed the basis of US Medicare funding for patients admitted to acute hospitals.

In 1984, a project was started at the Ministry of Health to study the feasibility of implementing this system in Portugal. The project was the result of a contract between the Portuguese Ministry of Health and the U.S. Agency for International Development. For the studies to adapt the American model to the Portuguese reality, this project relied on consultancy from the Health Systems Management Group, under the direction of Prof Robert Fetter from Yale University, and the US company Solon Consulting Group

Ltd, (which has since been acquired by the US company 3M), under the direction of Prof James Vertrees.

In 1989, the first tests were carried out on the use of DRGs as a basis for financing hospital admissions. With Normative Circular no. 1/89 from the Office of the Secretary of State for Health, the classification of patients into DRGs became widespread and compulsory, and the first DRG price lists to be used by the SNS were approved by Ministerial Order 409/90 of 31 May. It was precisely in 1990 that the concept of casemix obtained through DRGs was used for the first time to calculate the financing of hospitalisation in SNS hospitals.

Currently, with regard to the Programme Contracts, the inpatient, surgical outpatient and part of the medical outpatient production lines are fully funded on the basis of this patient classification system, representing around 51% of the total funding for NHS hospitals in 2009. The financing of these production lines results from the product between the base price, the casemix index and the number of equivalent patients.

On a monthly basis, information on DRGs from all NHS hospitals is collected in order to be included in the National DRG Database, which is hosted by the ACSS.

As with any patient classification system, DRGs require the collection of a CMD, with the main diagnosis (the one that, after studying the patient, was responsible for their admission to hospital) being decisive for the grouping, the secondary diagnoses (all the other diagnoses associated with the patient's clinical condition, which may lead to complications or comorbidities), the procedures carried out, the patient's age and sex, their fate after discharge (transferred, left against medical advice, died) and their birth weight (in the case of newborns).

For the purposes of coding hospital discharges in terms of diagnoses and procedures, so that episodes can be grouped into DRGs, the International Classification of Diseases 9th Revision Clinical Modification - ICD-9-CM (classification of diagnoses and procedures resulting from the US adaptation of the International Classification of Diseases 9th Revision, ICD 9 of the World Health Organisation - WHO) has been used in Portugal since 1989.

The main feature that distinguishes DRGs from other acute patient classification systems is that it was the first patient classification system to allow the measurement and definition of a hospital's casemix to be used for clinical and hospital management and as the basis for hospital funding. Although originally created in the USA, the basic concepts have been adapted and developed in numerous other countries, supporting both the financing and analysis of hospital production. Countries such as Germany, France, the United Kingdom, the Scandinavian countries, Australia and Canada have developed patient classification systems whose genesis derives from the DRGs originally created in 1983 in the USA, creating their own algorithms and episode groupers for this purpose.

Portugal has always opted to adopt the grouper existing in the U.S. The grouper currently in force is the All Patient DRG, version 21 (AP-DRG), introduced through the publication of Ministerial Order no. 567/2006 of 12 June. It is part of the family of DRG groupers and was originally used in 1988 in the state of New York. It was developed following the extension of prospective payment by DRG in that state to all patients in acute hospitals (and not just Medicare beneficiaries, i.e. patients aged 65 and over), and the need for a grouping system that reflected the characteristics of this type of patient. Developed from the original Medicare grouping, the AP DRG introduced significant changes for obstetrics, newborns, transplants, burns and HIV patients. For this reason, it was concluded that it would be better suited to the spectrum of patients admitted to NHS hospitals.

Once the "final GDH" of each inpatient episode has been calculated, that episode will be in a position to be invoiced by the EPE Hospital to the supervisory body, so rigour and timeliness in this classification are crucial to guaranteeing a correct and accurate determination of care activity.

According to Rosen (1999) et al, *episode groupers are critical to the analysis of health care delivery, since they focus on the entire process of care. Although all the groupers reviewed have many strengths, much developmental work still needs to occur in order to standardise the measurement and operationalisation of episodes of care as units of*

analysis. Furthermore, until the data sources used are more valid and reliable, they will at best remain gross screening measures of quality.

According to Zafirah (2018), *the accuracy of clinical coding is crucial in the assignment of Diagnosis Related Groups (DRGs) codes, especially if the hospital is using Casemix System as a tool for resource allocations and efficiency monitoring.*

Following the study *Potential loss of revenue due to errors in clinical coding during the implementation of the Malaysia diagnosis related group (MY-DRG®)* carried out on a sample of 464 clinical records, Zafirah identified coding errors in 89.4 per cent of the selected sample.

Based on this work, he concluded the following: *the quality of coding is a crucial aspect in implementing casemix systems. Intensive re-training and the close monitoring of coder performance in the hospital should be performed to prevent the potential loss of hospital income.*

Now, more or less contemporaneously, we can identify several studies on DRGs that refer to the inevitability of reliable records as a central element in maximising revenue, which naturally results from not recording medical acts. However, in a context of fragile internal control systems, disparate, arbitrary and almost discretionary organisational structures, this will clearly be one of the determining factors in the interpretation of operational risk in an EPE Hospital.

Chapter 5 - Operational Risk Management

5.1. Operational risk

Nowadays, companies are inserted in highly competitive environments, and it is necessary to recognise not only the value that can be created through intangible assets, but also the respective risks. There is therefore a need to develop tools and techniques to manage exposure to these risks (Longo, 2012).

In recent years there has been a rapid and widespread development of models to manage operational risk. This is due to compliance rules and also to the recognition that the complexity and sophistication of systems requires a robust assessment of this type of risk in order to increase the soundness of business processes. However, in addition to increasing the soundness of business processes, effective application of operational risk management can represent new financial opportunities for the organisation (DALLA VALLE; GIUDICI, 2008).

According to Hendges (2012), the concepts that permeate market decisions are return, uncertainty and risk. Risk is considered to be the measure of uncertainties associated with effective returns, i.e. risk is associated with the probability of losses and uncertain results.

Lunkes (2010) states that risks can come from external or internal sources, such as political, economic, physical and technological changes. The author adds that internal risks can be reduced through the co-operation of those responsible, while external risks require an understanding of the competitive forces faced by the company, the impact of new products and services, technological innovations, as well as environmental and social changes.

The performance of any company in a market economy is based on various risks. A company is exposed to a variety of risks, such as adopting an incorrect strategy, incurring natural disasters or accidents, or even falling into disgrace in the eyes of the

public, either because of reputational problems or because of changing customer preferences (CARVALHO, 2003).

According to Crouhy, Galay and Mark (2008), risks are classified into the following categories: market risk, credit risk, liquidity risk, operational risk, legal and regulatory risk, business risk, strategic risk and reputational risk.

For Tang (2006) operational risks result from the uncertainty of future events in the normal course of business, as opposed to the risks of interruption in the event of natural or man-made disasters.

According to Hahn and Kuhn (2012) operational risk covers the loss of inadequate internal processes or failures in internal control, represented by people, tools, methods, procedures and systems. Thus, a high operational risk represents a significant threat to the company's objectives.

In recent years, operational risks have attracted the attention of the banking sector because the Basel Committee has included this component in the capital requirements and it has been considered as part of the inspection criteria (FENG-GE; PING, 2012).

Operational risk must be taken into account by organisations, as it covers unexpected losses resulting from incorrect staff operations, a lack of systems, inadequate control, unauthorised activity or external events. Internal processes also arise from external events that are not always under an organisation's control (CHORAFAS, 2004).

Employees in an organisation are responsible for severe losses due to errors resulting from incompetence, bad decisions or failure to comply with the rules, often in an attempt to achieve a goal or improve customer service. Because of this, and the fact that operational risk is part of any activity, it is very difficult to fully mitigate. However, it is worth emphasising that increasing awareness goes a long way towards reducing exposure to this risk (LONGO, 2012).

In the context of this approach to operational risk, it is clear that it is difficult to apply an operational risk management model to the health sector because in order to identify errors resulting from incompetence, bad decisions or lack of compliance with rules, a management context is needed that presupposes a qualitative and quantitative assessment of the performance of care activities in a systematic way, Unfortunately, this is not the case in the universe analysed in this study, but it would be fantastic if it existed one day, not only because, according to Woods (2009), risk management is already an integral part of corporate governance processes, helping as an important tool in achieving their objectives.

Risk management serves as a support for decisions, because based on it, the best investments can be chosen considering the risks involved. Companies are therefore increasingly relying on the help of risk managers, because through them the company can achieve better results (HENTGES, 2012).

Operational risk management is considered a decision-making tool, as it identifies operational risks and determines the best courses of action for any given situation (GROMOFF; STAVENKO, 2012).

Operational risk management provides a logical and systematic means of identifying and controlling risks. So operational risk management is not a complex process, but it does require people to support and implement its basic principles. Adopting operational risk management offers individuals and organisations a powerful tool for increasing efficiency and reducing accidents (NAMAZIAN; ESLAMI, 2011).

Risk management involves processes, policies and structures that provide knowledge of what the business level of all risks is like. In this way, managers can periodise and invest capital appropriately, while lower-level managers can manage the possible risks in their areas WESTERMAN; HUNTER, (2008).

Regardless of how well structured operational risk management is, no company can manage it well if the people involved are not aware of the risk and looking for solutions

to mitigate it. Without a general awareness in the company, employees are apt to make mistakes that could easily be avoided, and such mistakes often lead to serious consequences. In order to encourage shared responsibility throughout the company, it is necessary to adhere to a culture of open discussion about the risks inherent in the organisation.

Operational risk management identifies, analyses, treats, evaluates, monitors and communicates the risks associated with organisational, operational and personnel activities and processes. This gives companies greater support in seeking alternatives to minimise losses and maximise opportunities (LUNKES, 2010).

Effective operational risk management provides the best way of dealing with operational risk, avoiding it and reducing the effects of losses (HENTGES, 2012).

Having a good awareness of operational risk does not mean that you are averse to it. However, being aware of operational risks enables managers to create strategies and make appropriate decisions. Without operational risk management, companies are unaware of the real extent of the operational risks they face, leaving them vulnerable to unpleasant surprises (WESTERMAN; HUNTER, 2008).

The entire company should be responsible for assessing operational risks, so that they can be quickly identified and measured, increasing the possibility of their elimination (LUNKES, 2010).

The adoption of efficient information management by the company can contribute significantly to the mitigation of operational risks. This integrated perspective has the potential to benefit both knowledge management and operational risk management, as information and knowledge (intangible assets) are recognised as fundamental to the performance of organisations. Many of the operational risks to which an organisation is exposed are the result of poor management of certain intangible assets. Furthermore, this exposure can be reduced through appropriate knowledge management practices (LONGO, 2012).

According to Namazian and Eslami (2011) there are six processes for effective operational risk management, namely:

- Identify risk factors;
- Assess risk factors;
- Analysing risk control measures;
- Making control decisions;
- Implement risk control measures;
- Supervising the model and improving it.

The COSO (The Committee of Sponsoring Organisation) report is a tool that helps companies manage risks and was created with the aim of helping with internal control, providing security and efficiency in operations, reliability in financial reports and compliance with legislation.

The COSO report helps to establish a common language around the internal control system. Since it was issued, risk management concepts and techniques have evolved at a rapid pace in the market. Before the COSO report, risk was generally seen in terms that reflected mainly negative results (CASSIDY, et al., 2001).

Among the tools available for developing operational risk management, the AS/NZ 4360 specification and the ISO 31000 standard stand out (BRANDÃO; FRAGA, 2012). ISO 31000 was created with the aim of harmonising standards, frameworks and regulations related to risk management. It anticipates the principles and generic guidelines for risk management, so that there is harmony between risk management and business processes (MACHADO, 2012).

The processes of identifying, analysing and evaluating operational risks carried out by the AS/NZ 4360 specification can be extended to various areas, as can the ISO 31000 standard, so the similarity between the two is inevitable (BRANDÃO; FRAGA, 2012).

In this context, the authors state that the AS/NZ 4360 and ISO 31000 standards present the operational risk management process through seven main elements: communicate and consult; establish the context; identify the risks; analyse the risks; assess the risks; treat the risks; monitor and review.

The importance of operational risk meant that the Basel and Solvency model used to determine capital requirements for banking and insurance included a specific autonomous module, where capital requirements were determined according to the specifics of each business (banking and insurance).

After a great deal of research, it turns out that in the health sector the risk management and operational risk models analysed have generally had a partial approach based on a speciality of care and/or a hospital process.

In national terms, examples of this are the doctoral theses on the relationship between efficiency and effectiveness applied to hospitalisation for cerebrovascular disease by Sílvia Lopes (2010) and hospital production and performance, applied to hospitalisation by Carlos Costa (2005).

5.2. Operational Risk Management in the Health Sector

Healthcare facilities have used a number of different approaches to operational risk management, taking into account the specific outputs of the care activity, with a particular focus on the potential negative effects that may originate in the clinical practice itself underlying the medical error, as well as the inability of healthcare facilities to have all the conditions to carry out the care activity in conditions of quality and safety.

This issue motivates the need to rethink the entire system by analysing in depth the determinants of operational risk in order to build a model that is more economical, efficient and effective for carrying out care activities.

Recently, enterprise risk management (ERM) has emerged as the preferred approach for various sectors of activity, so there is a need to adapt ERM models to the challenging specificities of healthcare activity.

This adaptation involves a top-down approach, involving the main stakeholders to create a consistent risk management architecture in view of the strategies and initiatives to be developed by the institution.

As a strategic approach, ERM supports the identification, assessment and management of risks and opportunities that can affect the organisation's strategy, financing and operational performance. In this sense, an integrated risk management programme should consider all materially relevant risk categories and, right from the start, this will be the first challenge: how to segregate the various risk categories?

The Solvency and Basel model in use in Banking and Insurance makes an essential segregation between the specific risk of the "business", in this case banking and insurance, and the operational risk underlying the respective activities.

In the case of banking and insurance, the aim of these models is to identify the capital requirements that companies will have to ensure in view of the risks they take on in their asset and liability portfolios. In this sense, it would be relatively simple to follow the same methodology to identify the capital needs of the EPE Hospitals to ensure the healthcare activity they carry out.

Then, within the scope of the Solvency and Basel models, there are standard models and partial or total internal models which, if used, must be approved by the sectoral supervisory bodies, with a view to preventing the models from being manipulated to minimise the capital requirements underlying the business.

Thus, one possible approach for an operational risk management model in healthcare could be to segregate operational risk from the specific risk of care activity.

This segregation makes perfect sense because each hospital has a specific care reality that is difficult to compare, but the operational risk underlying each organisation can be measured, compared and quantified.

There are tools that help with operational risk management, because through them companies can reduce their exposure to risks and the effects caused by them, and consequently help achieve better results.

Through the studies we have carried out, we have seen the tools that help:

Figure 3: tools to support operational risk management

Autor	Ano	Ferramentas
Torre-Enciso; Barros	2013	- controlo interno
Garliste	2013	- controlo interno - auditoria - quantificação do risco
Gromoff; Stavenki	2012	- sistema de comunicação interna
Feng-ge; Ping	2012	- simulação de monte carlo - método de baysian - modelos de VaR
Xie, Wu, Hu	2011	- apólice de seguro
Namazian; Eslami	2011	- infraestrutura tecnologica - cultura de risco; - controlo interno - mapeamento de risco apólice de seguro - auditoria
Li; Yi; Feng; Shi	2011	- apólice de seguro
Enescu	2010	- controlo interno - auditoria
Noni, Orsi, Pilotti	2010	- gestão do conhecimento
Petria, Petria	2009	- mapeamento de risco
Matis	2009	- cultura da consciencia de risco
Dalla Valle, Giudici	2008	- método baysian
Bodla; Verma	2008	- simulação de monte carlo
Barbu; Olteanu; Radu	2008	- quantificação do risco
Scandizzo	2005	- mapeamento do risco - modelos VaR

Source: own elaboration

Based on the figure above, 12 tools have been identified to help manage operational risks, the most common of which is internal control.

The studies by Torre-Enciso and Barros (2013), Namazian and Eslami (2011), Enescu and Enescu (2010) and Gârliste (2013) pointed to internal control as a tool to help manage operational risks, and these last three authors also pointed to auditing as an effective tool for managing operational risks.

In this context, internal control has five components that can be implemented in organisations:

1) Control environment;
2) Risk assessment;
3) Control activities (policies and procedures);
4) Information and communication;
5) Supervision.

The articles by Xie, Wu and Hu (2011), Namazian and Eslami (2011) and Li, et al (2011) pointed to the insurance policy as a risk mitigator in operational risk management. This is because the exposure to risk of a company that does not take out insurance is greater than the exposure of companies that do take out insurance.

Xie, Wu and Hu (2011) add that operational risk can be categorised into three types: expected loss, unexpected loss and catastrophic loss. Operational risk management must be prepared to protect against expected loss, as it is not possible to predict the events of catastrophic loss, so there is a need for insurance to deal with this problem.

The studies by Petria and Petria (2009), Namazian and Eslami (2011) and Scandizzo (2005) indicate that risk mapping is the basis for all the key components of operational risk management: identification, assessment, monitoring/reporting and mitigation. Risk mapping is an analysis tool in which risk exposures are linked to the relevant parts of the business process.

According to Scandizzo (2005) the key steps for risk mapping can be summarised as follows:

1 - Identification of key activities (process mapping);
2 - Analysing those responsible for the risk (people, processes or systems);
3 - Analysing risk factors (quantity, quality, criticality and failure);
4 - Risk identification;
5 - Identifying and analysing losses.

The studies by Feng-ge and Ping (2012) and Dalla Valle and Giudici (2008) indicate that the use of the Bayesian method generates a large reduction in the value at risk and, therefore, the capital requirement. This is an important result as it shows that the Bayesian method is an effective tool for managing operational risks due to the large cash savings that institutions that adopt this approach will have. In addition, the tests show that Bayesian methods provide more accurate estimates of loss distributions, making it possible to better capture extreme events. The use of Bayesian methods makes it possible to integrate scarce data and even imprecise quantitative data.

The Bayesian approach to operational risk would be to calculate the capital required to cover the estimated risks (DALLA VALLE; GIUDICI, 2008). The authors carried out various tests in their studies to prove that the Bayesian method almost always performs better than the classical approach. The Bayesian method has been proposed in operational risk management, just as the Monte Carlo simulation method has been used to measure operational risks in commercial banks.

The Monte Carlo simulation method was pointed out by Bodla and Verma (2008) and Feng-ge and Ping (2012) as a tool to help manage operational risks, as it can be used as an operational risk measurement technique.

The studies by Feng-ge and Ping (2012) and Scandizzo (2005) highlighted the VaR (Value at Risk) model as an aid tool, as it can be used to calculate the capital requirement for operational risks, as well as serving as a statistical measurement tool that identifies the expected loss over a specific time interval. VaR is a widely used way of quantifying risk, as it offers the advantage of integrating all risks into a single numerical measure, aggregating all assets and liabilities in the calculation and allowing the risks of different asset classes to be compared and integrated. VaR-based models still have shortcomings because they have not been fully tested, but many efforts are being made to improve existing models. Despite its limitations, VaR is increasingly used to quantify risks.

The culture of risk awareness was identified as a tool in the studies by Matis (2009) and Namazian and Eslami (2011). Whatever measurement methodology organisations adopt, effective operational risk management requires an integrated approach to developing staff skills.

It is necessary for a company's employees to be aware of the risks so that they can collaborate to avoid them. Gârliste (2013) and Barbu, Olteanu and Radu (2008) identify in their articles that risk quantification is a helpful tool, as it offers advantages such as identifying the operational losses to which they are exposed, modelling extreme events and helping to incorporate risk reduction quantification into the decision-making process. Banks that manage and measure operational risks can reduce their costs and are less vulnerable to systemic problems.

According to the study by Gromoff and Stavenko (2012) a tool for successful operational risk management would be the implementation of an internal communication system, followed by the interconnection of the following subsystems:

- The belief system - a set of documents distributed among employees, where the company's corporate values, objectives and development directions are fixed, with the aim of seeking employee collaboration and loyalty, thus increasing professionalism and personal effectiveness.
- Restriction framework - a set of rules that regulates the acceptability of actions determined during the task. This system includes legislative acts and business execution code, where prohibited actions and behaviours are determined. The purpose of the restriction framework is to maintain safety zone frameworks and avoid the risk of improper actions.

- Control system - controlling the rules and procedures established and indicated in the workflow. The aim of the control system is security and increased information in asset management.
-Monitoring system - set of activities and evaluations that determine the effectiveness of the organisation's operations, with the aim of implementing the system in accordance with the procedures established by the regulations.
Knowledge management was indicated in the study by Noni, Orsi and Pilotti (2010) as a helpful tool, as according to the author it is the key to success in guaranteeing the organisation's sustainability. Longo (2012) reinforces this idea by stating that appropriate knowledge management practices reduce exposure to many of the operational risks that an organisation is susceptible to. Namazian and Eslami (2011) point out in their study that technological infrastructure is a tool to help manage operational risks, as it allows the organisation to better monitor and manage business processes.

It is clear that the assessment of organisational processes to identify the existence of operational risks, as well as communication, discussion and learning are essential elements for the prevention and elimination of risks.

Following the terms of reference referred to by the ACSS, general guidelines are released every year for the contractualisation process between the central administration and the EPE Hospitals.

According to the terms of reference for 2018, the ACSS states that the health care contractualisation process aims to contribute to the general objective of guaranteeing high levels of access to the SNS, with quality and efficiency in the care provided to the population, encouraging the overall improvement of performance in the management of the resources available in the Health Sector, and includes three essential instruments, which must be present in a balanced manner:

- The contracting of activity - ensuring that providers commit to an expected production framework, given the needs of the population and the resources available;
- Financing models and payment methods - leveraging the behaviour of providers and aligning individual objectives with the overall care process;
- Performance measurement - measuring and comparing the performance of institutions in strategic and priority areas at national level, using process, output and result indicators.

From this perspective, the 2018 process considers the following general and transversal objectives:

i. Consider the priorities and metals defined in the National Health Plan - Revision and Extension 2020, and in the Regional and Local Health Plans;

ii. Strengthening epidemiological surveillance, health promotion and disease prevention, with intervention in the main determinants of health, through strategies to reduce mortality and the burden of disease and to guarantee the sustainability of SNS institutions;

iii. Encouraging the implementation of Clinical and Health Governance programmes that foster the creation of appropriate responses to health problems and needs;

iv. Hold NHS organisations accountable by negotiating clinical practices, objectives and measures to be implemented, ensuring timely monitoring and rigorous, participatory evaluation;

v. Promote the technical autonomy of NHS professionals and institutions, valuing the participation of all in defining the strategies to be implemented, according to the resources actually available;

vi. Encouraging the process of internal contractualisation, reinforcing the autonomy and responsibility of professionals and teams and promoting alignment, commitment and continuous improvement;

vii. Encouraging self-regulation mechanisms and positive competition between NHS organisations that benefit users, professionals, providers, payers and citizens in general;

viii. Improve interconnection and coordination between NHS care providers, as well as with the structures of the Social Sector and the Community, developing transversal follow-up plans aimed especially at chronic patients and those with multimorbidity;

ix. Encouraging Shared Resource Management in the context of SNS 7 (GPRSNS), seeking to maximise the capacity installed in institutions (namely in terms of access to MCDTs, outpatient consultations, surgical activity and use of equipment); GPRSNS was implemented following Ministerial Order 3796-A/2017, published in the 2nd series of the Diário da República, No. 87, of 5 May 2017. Terms of Reference for Health Care Contractualisation in the SNS for 2018;

x. Encouraging a culture of providing care in multidisciplinary teams, seeking to improve access, quality and continuity of care;

xi. Promoting Health Literacy and Self-Care, valuing users' journeys in the SNS, ensuring the definition of Individual Care Plans that involve users' needs and that can be monitored in information systems;

xii. Involving citizens and communities, through formal (citizens' offices and community councils) and informal bodies and practices that reinforce citizen power in the SNS and promote participation and citizenship in health, encouraging user education for informed self-management;

xiii. Awarding incentives to the institutions and teams with the best welfare and economic-financial performance;

xiv. Develop organisational management and management control skills, particularly in the areas of financial management, human resources, facilities and equipment, material resources and supplies, information systems, implementation of SIMPLEX+ measures, among others;

xv. Determine staffing levels, investment plans and financial allocations for each institution based on the health needs of the population, taking into account budget availability and the portfolio of services, as well as efficiency calculated through benchmarking, by institution and professional group;

xvi. Implement a policy of rational and effective use of medicines 8 (encouraging the use of generics and biosimilars), medical devices and MCDTs, combining the introduction of innovation with the containment of expenditure;

xvii. Encouraging the integration, dematerialisation and sharing of information between information systems and the continuous improvement of the accuracy and reliability of data, using the Electronic Health Record (EHR);

xviii. Valuing the use of information and communication technologies for the provision of health care, encouraging the dissemination of Telehealth

responses that contribute to improving efficiency and increasing equity in access to the SNS;

xix. Auditing processes and results, ensuring correspondence between practices and the procedures or criteria pre-established in good practice, as well as recording and invoicing the activity carried out.

For this process to be effective, it is necessary to promote a culture of commitment and responsibility at all levels, valuing the 3 phases of the contractualisation process:

1. Negotiation:
   It covers the preparatory work for the negotiation up to the signing of the commitments and takes into account what is recommended by the Health Policy and the restrictions associated with negotiation and risk sharing;

2. Monitoring and follow-up:
   This is the phase in which information on the commitments made is systematically collected and measures to correct any deviations are discussed;

3. Evaluation:
   This is a crucial phase that closes the contractualisation cycle and a time for accountability and reflection on the performance of all those involved.

The ACSS establishes a priori the financial resources to be contracted for the current year and determines incentives according to three essential dimensions:

- Access;
- Quality;
- Efficiency.

In addition, it defines a mix between national and regional objectives, and discriminates incentives between specialised healthcare, such as oncology or psychiatric care, and hospital-based healthcare (hospital centres and hospitals).

Figure 5: Incentives for Hospitals and Hospital Centres

Áreas	Ponderações
1. Objetivos Nacionais	**60%**
A. Acesso	**15%**
A.1 Percentagem de primeiras consultas médicas no total de consultas médicas	3%
A.2 Peso das consultas externas com registo de alta no total de consultas externas	3%
A.3 Mediana de tempo de espera da LIC, em meses	3%
A.4 Percentagem de episódios de urgência atendidos dentro do tempo de espera previsto no protocolo de triagem	3%
A.5 Percentagem de doentes referenciados para a RNCCI, avaliados/confirmados pela EGA até 2 dias antes da alta, no total de doentes referenciados para a RNCCI	3%
B. Qualidade	**25%**
B.1 Percentagem doentes saídos com duração de internamento acima do limiar máximo	3%
B.2 Percentagem de cirurgias realizadas em ambulatório, para procedimentos tendencialmente ambulatorizáveis *	3%
B.3 Percentagem de cirurgias da anca efetuadas nas primeiras 48 horas	3%
B.4 Índice de risco e segurança do doente	2%
B.5. Índice PPCIRA**	8%
B.6 Variação % de utilização de biossimiliares (em quotas e por DCI, 2018/2017)***	6%
C. Eficiência	**20%**
C.1 Percentagem dos custos com horas extraordinárias, suplementos e fornecimentos de serviços externos III (selecionados) no total de custos com pessoal	5%
C.2 Custos com pessoal por doente padrão, face ao melhor do grupo	5%
C.3 Custos com produtos farmacêuticos por doente padrão, face ao melhor do grupo	5%
C.4 Custos com material consumo clínico por doente padrão, face ao melhor do grupo	5%
Objetivos da Região	**40%**

Source: ACSS

Figure 6: Benchmarking incentives

Áreas
A. Acesso
A.1. Percentagem de utentes referenciados dos cuidados de saúde primários para consulta externa atendidos em tempo adequado
A.2. Percentagem doentes cirúrgicos inscritos em LIC com tempo de espera ≤ TMRG
B. Qualidade
B.1. Percentagem reinternamentos 30 dias, na mesma grande categoria diagnóstico
B.2. Índice de mortalidade ajustada
B.3. Índice de demora média ajustada
B.4. Percentagem de cirurgias realizadas em ambulatório no total de cirurgias programadas (GDH) – para procedimentos ambulatorizáveis
B.5. Demora média antes da cirurgia
C. Eficiência
C.1. Custos Operacionais por doente padrão
C.2. Doente padrão por Médico ETC
C.3. Doente padrão por Enfermeiro ETC
C.4. Percentagem de embalagens de medicamentos genéricos prescritos, no total de embalagens de medicamentos prescritos

Source: ACSS

In addition to the above-mentioned incentives, penalties are also defined which may not exceed 3% of the overall value of the programme contract established and originate in the following areas:

- Programmes to promote and improve access (36%) / 12 associated KPIs;

- Reporting and publication of management information (10%) / 5 associated KPIs;

- Registration, consultation, sharing and dematerialisation of processes (20%) / 10 associated KPIs;

- Revenue collection (4%) / 2 associated KPIs;

- Deviation in financial results (30%) / 1 associated KPI.

Referring only to the KPI for the last area, the ACSS defines a penalty for the EPE Hospital if EBITDA is 5% better than forecast ... this unusual situation sheds light on the "quality" of the staff that proliferate in the sector, as well as demonstrating the objective consequences of party patronage, which is responsible for a considerable proportion of appointments to the management positions of EPE Hospitals and dozens of upstream organisations.

In this context, based on the bibliographical research carried out in this work and the vast universe of KPIs presented by the ACSS in the incentives and penalties, it will be possible to operationalise in the following points an operational risk management model that makes sense and makes it possible to explain the performance of care units in a field of comparability that seems relevant and consistent.

Chapter 6 - Formulating Research Hypotheses

6.1. The Research Problem

According to a study by the National Statistics Institute, the next few decades are expected to bring changes that will force more developed societies to adapt, due to the foreseeable decrease in the working population, the growing ageing of the population, higher relative levels of urbanisation and greater economic growth in developing countries, which have a large part of the global youth population (Leuprecht & Goldstone, 2013) and can therefore gain projection and relative importance in the international system (Rodrigues, 2015, p.36).

If the 20th century was marked by population growth, the 21st century is likely to be marked by the global ageing of the population. However, on the relationship between ageing and health expenditure, there seems to be no consensus in the literature on the effects of ageing on health expenditure, with a vast body of literature refuting the ageing of the population as a main determinant of health expenditure (Campos, 2008; Przywara & Costello, 2008; Busse, Ginneken & Normand, 2012; Barros, 2013a; Sorenson, Drummond & Khan, 2013) and another literature, with more politicised documents, which considers there to be a strong positive correlation between the two variables (OECD, WHO and Portuguese Government), although this correlation is not confirmed in the vast majority of scientific econometric analyses developed over the last two decades in the area of health economics (Barros, 2013a, p. 36).36).

In recent decades, health spending in Portugal has grown much faster than GDP, and this is visible when we see that in 1970 health spending represented around 2.6 per cent of GDP, in 1990 it represented 6.5 per cent, in 2004 it represented 10 per cent and in 2017 it represented around 9 per cent.

Bearing in mind that Portugal has evolved from 94 doctors per 100,000 inhabitants in 1970 to 504 doctors per 100,000 inhabitants in 2017, this increase in spending is to some extent justified by the unquestionable improvement in access to healthcare compared to the situation in the 70s.

In order to cope with this increase in hospital costs, "management models" have been developed to maximise the efficiency and effectiveness of the universe of care providers.

In this context, 1995 saw the first experiment in the management of a public hospital by a private company at the Amadora-Sintra Hospital, and in 2002 a more comprehensive experiment took place, consisting of the transformation of 31 hospitals into S.A. hospitals.

The first experiment was a success and in 2017 we are continuing to focus on PPP hospitals, whose superior performance compared to hospitals managed directly by the state is clearly visible in all the comparative benchmarks published by the ACSS.

The experience of the S.A. hospitals was not followed and a hybrid legal entity (EPE hospitals) was created in which an attempt was made to replicate some of the rules of private management in public management.

This transformation of S.A. hospitals into E.P.E. hospitals was followed by the creation of hospital centres, which result in the aggregation of various care units under the same management with the aim of creating synergies and taking advantage of economies of scale in order to rationalise resources and eliminate redundancies.

More recently, another change took place in which the E.P.E. hospitals were transformed into reclassified public business entities (E.P.E.R.) with a view to providing the management of these hospitals with obligations similar to those of hospitals in the public administrative sector, for the purposes of budgetary control, the need for which became imperative after the last request for a financial bailout of the Portuguese Republic, by the last government of the then Prime Minister José Sócrates.

In this context of frenetic, successive and regular business transformations, is there any concept of operational risk management aimed at maximising efficiency?

This question makes it possible to approach risk management from the point of view of efficiency, but also to use this quantification to assess the extent to which operational management is being carried out in the best way, or in some way, given the resources available, regardless of the more or less linear way in which income and expenditure are weighted, or how an EPE Hospital is viewed in a business context, albeit in the specific context of the state business sector. This specific context implies that even in a context of under-financing, which is impossible for a private company unless allowed by creditors, it is possible, in a cunning but unoriginal way, to undervalue public debt by under-budgeting the state business sector, in this case in health.

Thus, we will try to identify materially relevant KPIs that, in an input/output relationship, are (co)related to the universe under study and, in this sense, we will try to use the maximisation of efficiency as a *proxy to* determine whether hospitals are optimised in terms of operating costs, i.e. whether we are making the best possible use of the installed capacity and thus optimising the operating result of the EPE Hospitals.

- **This was the rationale behind this study**

In this way, the management model underlying this analysis, if applied, would be based on continuous monitoring, which would imply that the management of the most efficient hospitals would be rewarded and that of the least efficient hospitals would be replaced, in a totally independent manner, based on clear and transparent criteria, and therefore totally unrelated to the various political cycles and *ad-nomine* appointments.

In terms of approach, we have opted for efficiency analysis, where we will analyse the relationship between the results obtained versus the resources employed on the efficiency frontier.

There are three measures of efficiency in economic terms: technical efficiency, which measures the relationship between the inputs used and the outputs obtained, allocative

efficiency, which refers to the proportion of utilisation of inputs taking relative prices into account, and total economic efficiency, which includes all of the above.

In this work we will use technical efficiency as a clear and unequivocal relationship between the use of hospital resources and the production of care outputs, in this context we will deduce the following research questions that will help us to understand the main objective, described above in the introduction chapter:

- Are the available resources consumed efficiently in order to maximise the results obtained?
- Are efficiency levels comparable between hospitals?
- Are management measures taken according to the hospitals' level of efficiency?

Testing these hypotheses will allow us to answer the questions raised, as we will consider the variable costs as operational costs and compare the results in order to guarantee consistency in the conclusions we will present.

Given the importance of this topic, there is a vast body of information, studies and articles on the subject of health cost growth and the impact on the health market. In order to establish the research hypotheses, after a vast review of the literature, we will consider the following approach according to Steinmann *et al* (2004), namely, we will analyse national studies on efficiency, international studies on efficiency, comparative studies between the two methods of calculating efficiency (parametric and non-parametric) and studies on efficiency in Portugal.

National and international studies on efficiency

Byrneswt al (1994), in Analysing technical and allocative efficiency of hospitals, discusses efficiency measures relating to cost minimisation using the DEA approach, in a sample of 123 Californian hospitals in 1983. In this study, six inputs were considered, including various stratifications of health technician categories85In this study, six inputs were considered, including various stratifications of health technician categories,

auxiliary staff converted into working hours and number of beds as a proxy for capital. In terms of outputs, they considered discharges from surgery, the ICU and the delivery theatre.

The results showed that the hospitals in the universe considered showed higher allocative inefficiency than technical inefficiency, which implies that if these hospitals had a performance equivalent to best practice, it would result in a 40 per cent saving in the average cost of patients discharged.

Fare et al (1994), in *productivity in swedish hospitals: a malmquist output index approach, analysed* hospital efficiency in Sweden and calculated evolution indices based on Malmquist indices. In this research, they analysed the main *drivers of* productivity in seventeen Swedish hospitals between 1970 and 1985 and the results made it possible to analyse efficiency in two components, the change in technical efficiency and the change in the efficiency frontier for each hospital. Fare et al. concluded that the use of Malmquist indices has several advantages over other classic measures (Tornquist, Pasche, Laspeyeres).

The results allowed them to conclude that there is a wide dispersion in the results of the various hospitals, and that there is technical inefficiency in the universe considered.

Dalmau-Atarrodona *et al* (1998), in *Market structure and hospital efficiency: evaluating potential effects of deregutation in a national health* service, analyse hospital efficiency in a group of hospitals in Catalonia according to market structure in order to evaluate the impact of deregulation policies in the context of market reforms in the national health service in Europe.

The results allowed them to conclude that two thirds of hospitals operate below the efficiency frontier with an average index of 0.84. The results suggest that the number of competitors contributes positively to technical efficiency, and there is evidence that the differences in efficiency scores are due to environmental factors such as ownership, market and regulatory structure.

Linna (2000) analysed the reform of health financing and changes in the productivity of hospitals in the Netherlands following the 1993 reform, which changed the main *drivers of* financing. In this work he used the Malmquist index, which makes use of linear programming methods.

The results show that there are positive changes in productivity in response to changes in the *modus operandi of* financing.

Biorn et al (2003) also analysed the effect of changing the financing scheme on the efficiency of Norwegian hospitals. In this study they sought to identify the impact of the activity-based financing scheme, namely on the volume of care activity and its complexity.

In this study, the DEA approach was used and the results show that technical efficiency has improved, although it is not as evident in relation to cost efficiency.

Zhang et al (2017) in *Impact of the local public hospital reform on the efficiency of medium-sized hospitals in Japan* analysed the results in terms of efficiency of the public reforms carried out in 2007 and concluded that it is necessary to improve the operationalisation of the measures at local level in order to overcome systemic constraints.

Mobley *et al* (1998) analysed the efficiency of Norwegian hospitals with Californian hospitals operating in a context of less regulation and greater competition, using the DEA methodology and concluding that the scale and regulation of Norwegian hospitals improves long-term efficiency, essentially due to better use of the productive factor capital.

Seinmann *et al* (2004) carried out a study comparing the efficiency of German and Swiss hospitals, using DEA methodology, and concluded that German hospitals have higher efficiency scores than Swiss hospitals.

Braithwaite *et al* (2017) *in Health system frameworks and performance indicators in eight countries: A comparative international analysis* compared the performance of health institutions in Australia, Canada, Denmark, England, the Netherlands, New Zealand, Scotland and the United States. In this study, they analysed two dimensions of indicators, namely the "national" consistency of indicators and relevance.

Of all the 401 indicators used in the various countries, they concluded that only 45 are used in more than one country, so this issue should be taken into account when making comparisons between countries in order to ensure consistency in the results presented.

Comparative studies of efficiency methodologies

Banker (1986) compared the results of parametric and non-parametric approaches by analysing a conventional translog cost function versus the DEA method. In this study, he identified a number of similarities and differences between the two methods in the choice of constant, increasing or decreasing returns to scale and in the estimation of marginal rates of transformation of outputs and technical inefficiency of hospitals.

Lopez-Vazcarcel et at (1996) compared the results of technical efficiency measures obtained through DEA with cost/efficiency indices from the ethocascal frontier in a sample of hospitals in Spain.

Linna et at (1998) analysed the efficiency of Finnish hospitals by comparing the results of the DEA approach and parametric methods. The authors conclude that the results obtained are independent of the methodology used and that based on DEA they were able to identify various factors that contribute to technical, scale and allocative efficiency. They also estimated a level of inefficiency of between 8-15%, split between technical and allocative inefficiency.

Efficiency studies in Portugal

Lima (2000) used translogarithmic functions in his research and adjusted the translog model to the production and cost structure of public hospitals.

Harfouche (2005) assessed the technical efficiency of a universe of hospital services using a non-parametric efficiency frontier approach, identifying staff costs, costs of medicines and clinical consumables and other costs (amortisation, financing, etc.) as input variables. The output variables were the activity recorded in the inpatient, outpatient and emergency departments.

Barros (2003) believes that the performance of each hospital should be compared with its potential for improvement, so it will be necessary to know the starting point in terms of the efficiency ranking of the various hospitals.

In the study he carried out at the 8th national meeting of health economics, using DEA and SFA methodologies on data from 2000, Pedro Pitta Barros identified the following conclusions, among others:

- In 2000, the global level of technological inefficiency was around 20 per cent;

- The overall volume of savings if all the hospitals in the sample became efficient would be around 300 million euros (2000 figures).

Costa et al (2007), as part of the National School of Public Health, carried out a study on the evaluation of hospital performance with data from 2004 and 2005:

- There is great heterogeneity in the performance of hospitals, particularly between the three indicators chosen (non dixit, mortality, complications and readmissions) but also in terms of performance by disease groupings;

- Finally, it should also be noted that the discussion on the best methodologies for evaluating hospital performance should be generalised, with a view to making the most of them, whether or not they include more dimensions and indicators, always bearing in

mind that although this objective is a goal in itself - informing health market agents - it is a means - identifying clues that will make it possible to improve the activity and functioning of hospitals.

Gonçalves (2007), in his analysis of hospital efficiency, concluded that the creation of two hospital centres does not translate into an improvement in technical efficiency, with the hospital costs associated with the hypothetical unit made up of the hospital centres being higher than the sum of the costs of the individual hospitals.

Morais Nunes (2018) assessed productivity in 18 hospital centres created through a process of merging hospital entities that took place gradually between 2006 and 2011. The main objective of this study was to verify whether there was, as expected, an improvement in productivity after the introduction of this merger policy. The methodology used was the Malmquist index, which measures total factor productivity between two data points in terms of distance function scores based on the prior use of a non-parametric method to estimate frontier functions.

As a result, he concluded that the creation of 18 hospital centres has generated, in terms of immediate effects, an improvement in productivity, but this has been restricted since 2011 due to the influence of the external economic intervention programme applied to Portugal by the International Monetary Fund, the European Central Bank and the European Commission.

6.2. Formulating Research Hypotheses

Following on from the literature review above, the subject of hospital efficiency is a clearly desirable topic for the universe of researchers working in this area. However, qualifying management performance in terms of efficiency is less usual, as questions of comparability can be raised to justify less successful performances.

To try to answer this question, we will try to compare hospitals that appear to be comparable, not only in terms of their legal form (hospital centre, local health unit and

hospital), but also in terms of the socio-economic and geographical specificities that underlie them.

To try to answer the research questions, we will establish a set of hypotheses with the aim of answering the starting question and the derivatives listed in this work.

Research hypothesis I:
There is a cause-effect relationship between the resources available and the care results obtained in the EPE hospitals.

Research hypothesis II:
The technical efficiency frontier shows similarities between the various hospital models, namely local health units, hospital centres and hospitals.

Research hypothesis III:
The technical efficiency frontier shows similarities between groups of hospitals in terms of funding

Research hypothesis IV:

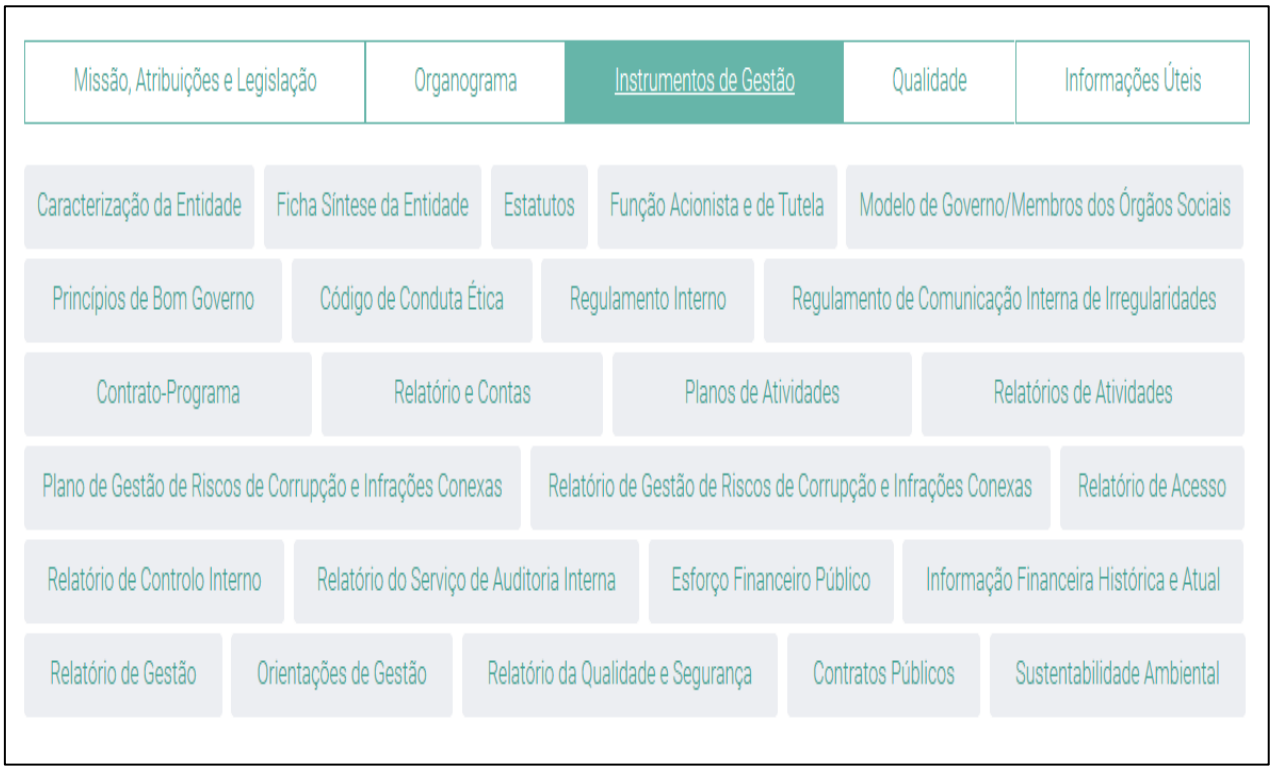
More efficient hospitals guarantee better access to care

In addition, we found that the majority of the forty EPE hospitals did not provide all the mandatory information, as can be seen in the table below.

In 2016, shortly after taking office, the Minister of Health, Prof Dr Adalberto Campos Fernandes, met with representatives of all the EPE Hospitals and stated that the information below was to be made public.

In 2018, unfortunately, it is not possible to verify that all the information is available in this way, nor in more obvious alternative ways, for example on the entities' *websites.*

Figure 7: Management Instruments - EPE Hospitals



Source: Health Portal

As of the date of this study (October 2018), around half of the EPE hospitals had not made their accounts report for the 2017 financial year available, and we have also identified one EPE hospital that has only publicly released its accounts report for 2013.

For this reason, in order to ensure comparability, we will use information for 2015 and 2016 from all the EPE hospitals that have made it available, and these hospitals will be our sample for the purposes of this research.

Thus, the information available was obtained in a challenging context since the homogeneity of the content disclosed, lack of information in the databases used and subjectivity in the preparation of the reports did not facilitate comparability between organisations and, in many cases, resulted in the omission of materially relevant information.

In addition, the *websites of* the EPE hospitals proved to be complex, not very functional and once again lacking in mandatory content.

In this sense, in an intelligible context, taking into account the factual context, the answer "Is the information on operational and assistance results disclosed in a transparent manner?" will not justify the establishment of a research hypothesis, since, at the time this work was carried out, a simple consultation of the information bases will show that the available data is not up to date.

I'm sure you'll be able to verify this on the date of submission of this work via the website: https://www.sns.gov.pt/institucional/entidades-de-saude/

Chapter 7 - Methodology

7.1. Introduction

Based on the above hypotheses, various estimations will be carried out using the efficiency frontier methodological approach, for which purpose we have collected the financial statements of the universe of all forty EPE Hospitals.

In other words, we try to use the maximisation of efficiency as a *proxy* to determine whether the hospitals are optimised in terms of operating costs, or whether we are making the best possible use of the installed capacity and thereby optimising the operating result of the EPE Hospitals.

The database used was as follows:

https://www.sns.gov.pt/institucional/entidades-de-saude/

Based on the information provided by the EPE hospitals, we built a database in which we included all the variables underlying this study, which will be detailed in the following sections of this paper.

For the reasons mentioned above, in order to ensure comparability, we will use information for 2015 and 2016 from all the EPE hospitals that have made it available, and these hospitals will be our sample for the purposes of this research.

In this context, the hospitals considered in our sample will be the following:

- Algarve Hospital Centre;

- Barreiro Montijo Hospital Centre;

- Coimbra Hospital Centre;

- Douro and Vouga Hospital Centre;

- Gaia Espinho Hospital Centre;

- Leiria Hospital Centre;

- Lisbon Central Hospital Centre;

- Lisbon North Hospital Centre;

- Lisbon West Hospital Centre;

- Médio Tejo Hospital Centre;

- Médio Ave Hospital Centre;

- Porto Hospital Centre;

- Povoa Hospital Centre;

- São João Hospital Centre;

- Centro Hospitalar de Traz os Montes;

- Viseu Hospital Centre;

- Barcelos Hospital;

- Evora Hospital;

- Fernando Fonseca Hospital;

- Figueira da Foz Hospital;

- Garcia de Orta Hospital;

- Santarém Hospital;

- ULS Alto Minho;

- ULS Castelo Branco;

- ULS Guarda;

- ULS Litoral Alentejano;

- ULS Matosinhos;

- ULS Northeast;

We excluded the Portuguese Oncology Institutes from the sample, as they have a mode of operation that is not comparable with the others. Thus, this sample of 28 EPE hospitals represents 76 per cent of all EPE hospitals except the IPO, which is why it is unequivocally representative of the total universe. Of these EPE hospitals, we considered 16 Hospital Centres (49%), 6 Hospitals (18%) and 6 Local Health Units (24%).

This sample includes 18% of hospitals in the Greater Lisbon area, namely Centro Hospitalar Barreiro Montijo, Centro Hospitalar Lisboa Norte, Lisboa Central e Lisboa Ocidental, Hospital Fernando Fonseca, Hospital Garcia de Orta, as well as 15% of hospitals in the Greater Porto area, namely Centro Hospitalar do Porto, São João e Gaia Espinho and ULS de Matosinhos, and the remainder (67%) from other areas of the country.

It should also be noted that the Braga region is served by the Braga Hospital, which is run by a public-private partnership (PPP) and for this reason, although it is a relevant area in terms of population, and there are conditions for comparability with the others, it is not considered in this research study. Nevertheless, it is important to note that this PPP hospital shows a clear superiority in almost all of the *rankings* made available by the ACSS, compared to all comparable EPE hospitals, so even though this is not the subject of this work, it is *nice* information *to have* when analysing hospital operational risk management models.

7.2. Methodological approach

As mentioned above, in this work we will use the variable costs, as costs of an operational nature, to demonstrate the research hypotheses formulated.

To this end, we will use two conceptual assumptions, namely converting the costs to constant 2018 prices in order to eliminate the effect of the inflation that occurred between the period under analysis and the current period. On the other hand, we will not correct for the application of the *casemix* index, not only because this situation is already reflected in the financing of hospitals, but also because we will be comparing hospitals according to their financing group, which would make such a classification redundant.

Therefore, in this work we will use two types of approach, a deterministic approach, namely through the use of Malmquist indices, and a *stochastic* approach, through *stochastic frontier analysis*, as a complement to deterministic approaches.

In the estimations we will use a program developed by Tim Coelli (PhD), a professor at the Australian University of New England, namely the DEAP program which involves the data envelopment analysis (DEA) methodology based on Malmquist indices, and the FRONTIER program which involves the Stochastic Frontier Analysis (SFA) methodology through the estimation of transcendental logarithmic functions (translog) where operating costs are analysed as a function of output variables.

The *Data Envelopment Analysis (DEA)* methodology involves using linear programming methods to construct a non-parametric surface (frontier) on the data so that relative efficiencies can be calculated on this surface.

The software used in this work can be used for various models, the most typical of which are:

- Standard CRS (constant return to scale) models and DEA VRS (variable return to scale) models involving the calculation of technical and scale efficiencies. These models are suggested by FARE, GROSSKOPF and LOVELL (1994)

- The extension of the above models to introduce cost and allocative efficiency;

- The application of DEA Malmquist methods to calculate total productivity indices, technological changes, technical efficiency changes and scale efficiency changes. These methods are suggested by FARE, GROSSKOPF, NORRIS and ZHANG (1994).

All of these methods are available for use according to inputs or outputs. This software makes it possible to calculate estimates of technical, scale, allocative and cost efficiency.

In an attempt to clarify the concepts that will be used here, it is important to note that there are several alternative methods for calculating efficiency frontiers, but the two main methods are DEA and *stochastic* frontiers.

Both methods involve mathematical programming and econometric methods, in this work we will use DEAP software for the DEA method and FRONTIER software for the stochastic frontier method.

In terms of approach, we have to distinguish between the various measures in use.

With regard to *input-oriented measures*, Farell illustrated his ideas using a simple example of companies that use two inputs (X1 and X2) to produce a single output (Y), assuming the knowledge of an isoquant unit that makes it possible to establish the company as totally efficient in the use of X1 and X2, with a view to maximising the output Y.

These efficiency measures assume that the production function of the fully efficient company is known, which in reality is not the case, which is why isoquant efficiency will have to be estimated based on the information available in the various samples considered in these studies.

Output-orientated measures aim to answer the following question: How many units of X1 and X2 can you reduce proportionally in order to maintain production level Y?

This is the model we propose for assessing operational risk in non-financial public companies in the health sector, and now for EPE hospitals.

7.3. Input/output variables

The use of efficiency frontier models presupposes the use of input and output variables.

As **input variables**, we will use the following conceptual assumptions:

(i) For the DEA estimations, we will use:

- Number of doctors;
- Number of nurses;
- Location.

(ii) In the SFA estimations we will use the following KPIs:

- Personnel costs;
- Cost of goods sold and materials consumed;
- External supplies and services;

We have therefore not considered the operating results, but only their main *drivers, i*.e. the main operating costs, so as not to bias this work towards the under-budgeting of the EPE Hospitals, which is so much in vogue under the Stability and Growth Pact and is unfortunately more important than the economic and social cohesion underlying Portugal's integration into the European Union.

These variables have been used in several international studies on efficiency, for example, Lopez-Valcarel *et al* (1996) used the number of doctors, number of other staff and number of beds as input variables, Magnunssen (1996) used the input variables number of doctors, number of other staff and number of beds, Maniadakis (2000) used the number of doctors as input variables, Maniadakis (2000) used the number of doctors, number of nurses, number of other staff, number of beds and occupied space as input variables, Gonçalves (2008) used the number of doctors, number of nurses, number of other staff and capacity as input variables and, finally, Khushalani, Ozcan (2017) considered the number of beds as a good proxy for capital expenditure and the number of non-medical staff as a good proxy for total expenditure per bed.

In this work we will consider the number of doctors, the number of nurses and the capacity.

Number of doctors:

The number of doctors, as an essential factor in the functioning of a hospital, will be considered in this study as one of the main items. The introduction of this input is intended to relate total hospital production to the number of doctors available to the hospital for care activities. This KPI will be used as a proxy to identify the size of the productive factor labour.

Number of nurses:

As with the number of doctors, the number of nurses is another essential factor in the functioning of a hospital, which is why it will be considered in this work as another of the main items. The introduction of this input is intended to relate total hospital

production to the number of nurses available to the hospital for care activities. This KPI will be used as a proxy to identify the size of the productive factor labour.

Location:

Commonly referred to as the "number of beds", as mentioned above, a hospital's capacity is a good proxy for capital expenditure and is commonly used in hospital efficiency studies. This KPI therefore attempts to represent the capacity installed in each hospital to respond to situations involving hospitalisation.

In the SFA estimates we will use the three main categories of operating costs for an EPE hospital, namely staff costs, costs of medicines and costs of clinical consumables.

Analysing the operating accounts of all the EPE hospitals, it can be seen that staff costs generally account for more than 50% of total costs, but this situation will have to be properly contextualised in the course of this work.

As **output variables**, we will use the following conceptual assumptions:

- Number of outpatient appointments;
- Number of emergency episodes;
- Number of surgeries performed;

In studies of a similar nature, Fare et all (1993) considered the number of emergency episodes and the number of day hospital sessions as output variables, Burgess et al (1998) used the number of outpatient consultations as an output variable and Khushalani, Ozcan (2017) considered the number of surgeries and emergency episodes as output variables.

Number of outpatient appointments:

The number of outpatient consultations is the total number of all consultations for all specialities carried out at an EPE Hospital in a given period of time. This output variable is therefore a good proxy for measuring hospital production, based on

programmed activity, i.e. activity for which it is possible to determine supply and organise service provision given a certain volume of demand.

Number of emergency episodes:

The number of emergency episodes is the total number of all emergency episodes carried out at an EPE Hospital in a given period of time. This output variable is therefore a good proxy for measuring hospital production, based on unscheduled activity, which cannot be accurately estimated a priori, given its contingency nature.

Number of surgeries performed:

The number of surgeries performed consists of the total number of all surgeries of all specialities performed in the operating theatre and outpatient department of an EPE Hospital in a given period of time. This output variable is therefore a good proxy for measuring hospital production, based on the mix of scheduled and unscheduled activity, depending on whether the patient's origin is planned or unplanned when they enter the emergency room.

We therefore believe that the input and output variables considered in this work are representative of the essentials of all the care activity carried out in a hospital.

We didn't consider the complementary means of diagnosis and therapy MCDTs and their respective KPIs because the information available is very scarce and doesn't appear to have qualitative attributes that would justify analysing the data. On the other hand, it doesn't present conditions for comparability because this is a service that EPE Hospitals outsource, but in different %'s.

This situation will naturally have an impact on the other input and output variables, since there are professionals (doctors and nurses) allocated to these tasks, so the results will be adjusted with an error rate between 2-5%, dependent of the volume of its assistance activity.

7.4. Data Analysis

Taking the above variables into account, in this chapter we will analyse the results of the descriptive statistics, with a view to characterising the data that make up the sample under study, taking into account the time horizon between 2015 and 2016.

When we chose the number of variables, we took into account the degrees of freedom inherent in the sample, which is why we introduced a rule of thumb about the relationship between the number of observations (EPE Hospitals) and the number of explanatory variables.

In terms of analysing the **individual variables**, we're going to analyse the relationships between the input and output variables:

- Number of surgeries performed, number of doctors, number of nurses (D1);

- Number of outpatient appointments, number of doctors (D2);

- Number of emergency episodes, number of doctors and nurses (D3);

(D1)

Looking at the first dimension of analysis, we can see that the number of doctors only remained stable between 2015 and 2016 at the Algarve Hospital Centre (4% of the total sample), in other words, all the other hospitals (96% of the total sample) saw a change in the number of doctors.

It can be seen that in three hospitals, 11 per cent of the total sample, there was a reduction in the number of doctors and that in the remaining twenty-three hospitals there was a maintenance or increase in the number of doctors between 2015 and 2016, or an effort to reinforce the fundamental means for carrying out care activities.

We identified one hospital (4 per cent of the total sample) where, despite the reduction in the number of doctors, there was an increase in the number of surgeries. On the other hand, we also identified six hospitals (21 per cent of the total sample) where, despite the increase in the number of doctors, there was a decrease in production.

Figure 8: Ratio between number of doctors and surgeries

	# doctors			# surgeries		
	2015	2016	%	2015	2016	%
ULS North East	303	295	**-2,64%**	7635	6518	**-14,63%**
ULS Guarda	259	256	**-1,16%**	7616	8212	**7,83%**
CH Médio Ave	208	207	**-0,48%**	8009	7936	**-0,91%**
CH Algarve	410	410	**0,00%**	13686	13636	**-0,37%**
ULS Matosinhos	590	591	**0,17%**	6615	6462	**-2,31%**
CH Coimbra	1586	1594	**0,50%**	43563	43017	**-1,25%**
CH Lisboa Norte	1384	1398	**1,01%**	21448	21326	**-0,57%**
CH Médio Tejo	116	118	**1,72%**	9414	10507	**11,61%**
ULS litoral alentejano	87	89	**2,30%**	3011	4243	**40,92%**
CH Barreiro	259	265	**2,32%**	6263	6686	**6,75%**
CH Porto	1027	1051	**2,34%**	17643	18389	**4,23%**
CH Lisboa Central	1033	1071	**3,68%**	37675	38199	**1,39%**
ULS castelo branco	208	216	**3,85%**	6981	7224	**3,48%**
CH Lisboa Ocidental	502	522	**3,98%**	22472	22628	**0,69%**
H Evora	277	289	**4,33%**	14040	14168	**0,91%**
CH São João	831	868	**4,52%**	44159	43879	**-0,63%**
CH Tondela Viseu	475	507	**6,74%**	23304	24441	**4,88%**
H Fernando Fonseca	346	371	**7,23%**	13741	20047	**45,89%**
CH Leiria	339	367	**8,26%**	14778	15023	**1,66%**
H Santarém	162	176	**8,64%**	6548	7247	**10,68%**
CH Entre Douro e Vouga	231	255	**10,39%**	16420	16128	**-1,78%**
H Figueira da Foz	77	85	**10,39%**	6811	7098	**4,21%**
H Garcia de Orta	333	371	**11,41%**	14626	15852	**8,38%**
CH behind the hills	442	497	**12,44%**	10341	11447	**10,70%**
ULS Alto Minho	489	570	**16,56%**	13107	14268	**8,86%**
CH Gaia Espinho	733	864	**17,87%**	23470	24893	**6,06%**
H Barcelos	130	154	**18,46%**	4523	4561	**0,84%**
CH Povoa	130	157	**20,77%**	5296	5110	**-3,51%**

Source: Health Portal

This paradox is most acute at the Povoa Hospital Centre, where a 20.77% increase in the number of doctors reflected a reduction in the number of surgeries, while at the Barcelos Hospital, where investment was made in increasing the number of doctors, surgical activity stagnated compared to the same period last year.
Finally, it should be noted that in most hospitals, 68 per cent of the total sample, there is a proportional relationship between the increase/decrease in the number of doctors and the increase/decrease in the number of surgeries.

It should be noted that from the point of view of managing care, there is a direct relationship between the number of doctors and the number of surgeries (scheduled or urgent). The size of the team may vary depending on the surgical speciality under analysis, but as a rule, one or two surgeons and an anaesthetist are needed for each surgery.

Analysing the number of nurses, twenty-six of the twenty-eight hospitals (93% of the total) saw an increase in the number of nurses between 2015 and 2016. Of these 26 hospitals, only eight (30 per cent) saw an increase in the number of nurses and a reduction in the number of surgical operations.

Figure 9: Relationship between number of nurses and surgeries

	# nurses			# surgeries		
	2015	2016	%	2015	2016	%
H Barcelos	177	174	**-1,69%**	4523	4561	**0,84%**
CH Algarve	1448	1448	**0,00%**	13686	13636	**-0,37%**
ULS castelo branco	457	459	**0,44%**	6981	7224	**3,48%**
ULS litoral alentejano	341	344	**0,88%**	3011	4243	**40,92%**
CH Médio Ave	347	351	**1,15%**	8009	7936	**-0,91%**
CH Porto	1295	1317	**1,70%**	17643	18389	**4,23%**
ULS Matosinhos	761	774	**1,71%**	6615	6462	**-2,31%**
CH Tondela Viseu	823	842	**2,31%**	23304	24441	**4,88%**
CH Coimbra	2648	2725	**2,91%**	43563	43017	**-1,25%**
CH Lisboa Norte	1807	1863	**3,10%**	21448	21326	**-0,57%**
ULS North East	603	625	**3,65%**	7635	6518	**-14,63%**
CH Leiria	730	758	**3,84%**	14778	15023	**1,66%**
CH São João	2035	2122	**4,29%**	44159	43879	**-0,63%**

H Garcia de Orta	878	923	**5,13%**	14626	15852	**8,38%**
CH Lisboa Ocidental	1235	1299	**5,18%**	22472	22628	**0,69%**
ULS Guarda	634	667	**5,21%**	7616	8212	**7,83%**
H Fernando Fonseca	916	965	**5,35%**	13741	20047	**45,89%**
CH Entre Douro e Vouga	535	565	**5,61%**	16420	16128	**-1,78%**
CH Povoa	213	226	**6,10%**	5296	5110	**-3,51%**
CH Lisboa Central	2300	2449	**6,48%**	37675	38199	**1,39%**
CH behind the hills	846	903	**6,74%**	10341	11447	**10,70%**
H Figueira da Foz	191	205	**7,33%**	6811	7098	**4,21%**
ULS Alto Minho	819	892	**8,91%**	13107	14268	**8,86%**
H Evora	470	512	**8,94%**	14040	14168	**0,91%**
CH Barreiro	567	623	**9,88%**	6263	6686	**6,75%**
CH Médio Tejo	632	705	**11,55%**	9414	10507	**11,61%**
H Santarém	524	590	**12,60%**	6548	7247	**10,68%**
CH Gaia Espinho	1008	1142	**13,29%**	23470	24893	**6,06%**

Source: Health Portal

There is a direct relationship between the number of nurses and the number of surgeries (scheduled or urgent). The size of the team varies depending on the surgical speciality under analysis, but as a rule more than two nurses are needed for each surgery.

(D2)

Considering the second dimension, let's analyse the relationship between the number of doctors and the total number of outpatient consultations carried out.

It should be noted that this relationship is influenced by a factor that is materially relevant to the analysis, but impossible to rationalise due to the lack of credible data, which has to do with the number of outpatient consultations carried out by interns, i.e. doctors in training.

It is common in EPE Hospitals for junior doctors to have consultations carried out by their tutor, which means that from the point of view of analysing production, these consultations count as consultations carried out by doctor X, but they were actually carried out by the junior doctors allocated to that doctor.

Figure 10: Ratio between number of doctors and outpatient appointments

	# doctors			# external consultations		
	2015	2016	%	2015	2016	%
ULS North East	303	295	**-2,64%**	110738	107312	**-3,09%**
ULS Guarda	259	256	**-1,16%**	131059	133776	**2,07%**
CH Médio Ave	208	207	**-0,48%**	166547	157524	**-5,42%**
CH Algarve	410	410	**0,00%**	344751	345676	**0,27%**
ULS Matosinhos	590	591	**0,17%**	268610	278568	**3,71%**
CH Coimbra	1586	1594	**0,50%**	117225	120715	**2,98%**
CH Lisboa Norte	1384	1398	**1,01%**	700205	702362	**0,31%**
CH Médio Tejo	116	118	**1,72%**	173560	178473	**2,83%**
ULS litoral alentejano	87	89	**2,30%**	64625	76331	**18,11%**
CH Barreiro	259	265	**2,32%**	196133	200975	**2,47%**
CH Porto	1027	1051	**2,34%**	667945	674533	**0,99%**
CH Lisboa Central	1033	1071	**3,68%**	775501	751380	**-3,11%**
ULS castelo branco	208	216	**3,85%**	95494	97096	**1,68%**
CH Lisboa Ocidental	502	522	**3,98%**	462107	461690	**-0,09%**
H Evora	277	289	**4,33%**	207656	207261	**-0,19%**
CH São João	830,5	868	**4,52%**	737865	746930	**1,23%**
CH Tondela Viseu	475	507	**6,74%**	256925	263312	**2,49%**
H Fernando Fonseca	346	371	**7,23%**	310287	327542	**5,56%**
CH Leiria	339	367	**8,26%**	254251	253796	**-0,18%**
H Santarém	162	176	**8,64%**	146915	148728	**1,23%**
CH Entre Douro e Vouga	231	255	**10,39%**	303301	296160	**-2,35%**
H Figueira da Foz	77	85	**10,39%**	92765	95466	**2,91%**
H Garcia de Orta	333	371	**11,41%**	297390	297304	**-0,03%**
CH behind the hills	442	497	**12,44%**	301550	300694	**-0,28%**
ULS Alto Minho	489	570	**16,56%**	236886	245758	**3,75%**
CH Gaia Espinho	733	864	**17,87%**	503544	517432	**2,76%**
H Barcelos	130	154	**18,46%**	68602	71312	**3,95%**
CH Povoa	130	157	**20,77%**	80038	82602	**3,20%**

Source: Health Portal

The number of doctors in training and their respective specialities is a matter managed by the doctors' association, and it is practically impossible to predict how many interns the EPE Hospital will have in the future.

This situation is compounded by the fact that doctors, after their long and expensive training, can practise in any public or private provider. In other words, the costs of training professionals heavily penalise public hospitals with public management and for this reason any kind of comparison of performance between these and public hospitals with private management should, among other things, take this into account.

In this regard, we found that in seven (25 per cent of the total) of the twenty-eight hospitals, a higher number of doctors does not correspond to more consultations, and in only one hospital did we find that a lower number of doctors does not correspond to a lower number of consultations.

It should be noted in this regard that the Gaia Espinho Hospital Centre, Barcelos Hospital and Povoa Hospital Centre, where there was an average 19% increase in the number of doctors, only saw a 3% increase in the number of outpatient consultations.

Thus, taking into account the dimensions of analysis D1 and D2, it is possible to identify a proportional relationship between inputs and outputs, but for a considerable number of the sample the increase in "inputs" does not necessarily result in an increase in "outputs".

(D3)

Now considering the dimension of analysis (D3), we're going to analyse the relationship between the total number of professionals (doctors and nurses) and the total number of emergency episodes carried out.

Emergencies are unscheduled in nature, unlike surgery and outpatient appointments. For this reason, emergency management is based on forecasts of activity and the respective sizing of teams in line with these forecasts, which is why it is a more complex form of management because it is based on uncertainty and the possibility of low probability events occurring but with a very significant impact on services.

Curiously, there is a much more "rational" relationship between the number of emergency episodes and the number of doctors and nurses, with only one EPE hospital (4%) showing no such relationship. This issue could be related to the induction of demand by supply, it could be a consequence of the hospital-centred system or it could be the result of extremely cautious management, to the detriment of scheduled activity.

In any case, after analysing D1, D2 and D3 we can conclude that there is a strong relationship between the input variables and the output variables in the sample under analysis.

Figure 11: Relationship between number of doctors and emergency episodes

	number of professionals (M+E)			emergency ep number		
	2015	2016	%	2015	2016	%
CH Algarve	1858	1858	**0,00%**	350414	357174	**1,93%**
CH Médio Ave	555	558	**0,54%**	126072	130215	**3,29%**
ULS Matosinhos	1351	1365	**1,04%**	75422	80155	**6,28%**
ULS litoral alentejano	428	433	**1,17%**	92642	96031	**3,66%**
ULS castelo branco	665	675	**1,50%**	63363	67300	**6,21%**
ULS North East	906	920	**1,55%**	75333	78378	**4,04%**
CH Porto	2322	2368	**1,98%**	135896	143679	**5,73%**
CH Coimbra	4234	4319	**2,01%**	283637	294601	**3,87%**
CH Lisboa Norte	3191	3261	**2,19%**	206315	228205	**10,61%**
ULS Guarda	893	923	**3,36%**	102122	106123	**3,92%**
CH Tondela Viseu	1298	1349	**3,93%**	182524	180200	**-1,27%**
CH São João	2865,5	2990,4	**4,36%**	249925	262421	**5,00%**
CH Lisboa Ocidental	1737	1821	**4,84%**	151222	157596	**4,21%**
CH Leiria	1069	1125	**5,24%**	195180	204484	**4,77%**
CH Lisboa Central	3333	3520	**5,61%**	250124	258813	**3,47%**
H Fernando Fonseca	1262	1336	**5,86%**	258557	272833	**5,52%**
H Barcelos	307	328	**6,84%**	66969	69751	**4,15%**
H Garcia de Orta	1211	1294	**6,85%**	149736	164071	**9,57%**
CH Entre Douro e Vouga	766	820	**7,05%**	170845	180119	**5,43%**
H Evora	747	801	**7,23%**	72340	75961	**5,01%**
CH Barreiro	826	888	**7,51%**	141152	146196	**3,57%**
H Figueira da Foz	268	290	**8,21%**	72451	75470	**4,17%**
CH behind the hills	1288	1400	**8,70%**	177533	182273	**2,67%**
CH Médio Tejo	748	823	**10,03%**	143594	153872	**7,16%**
H Santarém	686	766	**11,66%**	125836	132716	**5,47%**

CH Povoa	343	383	**11,66%**	73551	74777	**1,67%**
ULS Alto Minho	1308	1462	**11,77%**	160496	165820	**3,32%**
CH Gaia Espinho	1741	2006	**15,22%**	167813	178568	**6,41%**

Source: Health Portal

In terms of the **integrated analysis of the variables**, we will analyse how the input and output variables relate to each other, based on the % contribution of each of the groups considered in this work:

- Production ratio per professional (D4);

- Operating cost per production ratio (D5);

- Ratio of professionals to operating costs (D6);

In these dimensions of analysis, we have chosen to use technical ratios that allow us to assess the performance of EPE Hospitals with a benchmarking rationale, where it is possible to see which are the best and worst *performers* in each pre-established analysis criterion.

A priori, it would be expected that the University Hospitals of Lisbon, Porto and Coimbra would show the worst performance given their training vocation, because although training activities are transversal to all hospitals, we would expect a higher prevalence in this type of institution.

(D4)

In this dimension of analysis, we will analyse the ratio of consultations per doctor. Despite the constraints and dehydrations mentioned above in relation to the activity carried out by intern doctors, by dividing the number of consultations carried out by the number of doctors, we can define a technical ratio that allows us to gauge the dynamics of consultations in an EPE Hospital.

Figure 12: Ratio of consultations per doctor

	consultations/doctor ratio		
	2015	2016	%
CH Povoa	615,68	526,13	**-14,54%**
CH Gaia Espinho	686,96	598,88	**-12,82%**
H Barcelos	527,71	463,06	**-12,25%**
CH Entre Douro e Vouga	1312,99	1161,41	**-11,54%**
CH behind the hills	682,24	605,02	**-11,32%**
ULS Alto Minho	484,43	431,15	**-11,00%**
H Garcia de Orta	893,06	801,36	**-10,27%**
CH Leiria	750,00	691,54	**-7,79%**
H Santarém	906,88	845,05	**-6,82%**
H Figueira da Foz	1204,74	1123,13	**-6,77%**
CH Lisboa Central	750,73	701,57	**-6,55%**
CH Médio Ave	800,71	760,99	**-4,96%**
H Evora	749,66	717,17	**-4,33%**
CH Tondela Viseu	540,89	519,35	**-3,98%**
CH Lisboa Ocidental	920,53	884,46	**-3,92%**
CH São João	888,46	860,52	**-3,14%**
ULS castelo branco	459,11	449,52	**-2,09%**
H Fernando Fonseca	896,78	882,86	**-1,55%**
CH Porto	650,38	641,80	**-1,32%**
CH Lisboa Norte	505,93	502,40	**-0,70%**
ULS North East	365,47	363,77	**-0,47%**
CH Barreiro	757,27	758,40	**0,15%**
CH Algarve	840,86	843,11	**0,27%**
CH Médio Tejo	1496,21	1512,48	**1,09%**
CH Coimbra	73,91	75,73	**2,46%**
ULS Guarda	506,02	522,56	**3,27%**
ULS Matosinhos	455,27	471,35	**3,53%**
ULS litoral alentejano	742,82	857,65	**15,46%**

Source: Health Portal

Desirably, this ratio could and should be complemented with another ratio that relates the number of possible consultations to the number of consultations carried out, and thus conclude on the productivity of the outpatient consultations production unit. However, this information cannot be obtained within the current context of

accountability by EPE Hospitals, where the respective criteria for reporting information are completely left to the free will of each management team, which in a highly politicised environment results in the lack of level of information available.

Even so, this dimension of analysis clearly reflects the drop in productivity inherent in the measure implemented by the government in June 2016, which reduced the working hours of health professionals from 40 hours a week to 35 hours a week.

This situation is reflected in 75 per cent of the EPE Hospitals considered in this sample, and given that the majority of EPE Hospitals are in technical bankruptcy, where the statutory auditors only assume continuity on the basis of the idiosyncrasies of the "State" shareholder, this essentially political and trade union measure has had the effect of reducing the productivity of the already unproductive care activity carried out by the EPE Hospitals.

The figures in figure 12 show an average ratio of consultations per doctor of 730.92 in 2015 and 699.02 in 2016, which divided by eleven working months and then by twenty-two working days means that, on average, a doctor carried out 3.02 consultations in 2015 and 2.89 consultations in 2016.

Figure 13: Ratio of emergencies per doctor/nurse

	emergency/medical ratio			emergency/nurse ratio		
	2015	2016	%	2015	2016	%
CH Povoa	565,77692	476,28662	**-15,82%**	345,30986	330,87168	**-4,18%**
H Barcelos	515,14615	452,92857	**-12,08%**	378,35593	400,86782	**5,95%**
ULS Alto Minho	328,21268	290,91228	**-11,36%**	195,96581	185,89686	**-5,14%**
CH Gaia Espinho	228,93997	206,67593	**-9,72%**	166,48115	156,36427	**-6,08%**
CH behind the hills	401,65837	366,74648	**-8,69%**	209,84988	201,85271	**-3,81%**
CH Tondela Viseu	384,26105	355,42406	**-7,50%**	221,77886	214,01425	**-3,50%**
H Figueira da Foz	940,92208	887,88235	**-5,64%**	379,32461	368,14634	**-2,95%**
CH Entre Douro e Vouga	739,58874	706,34902	**-4,49%**	319,33645	318,79469	**-0,17%**
CH Leiria	575,75221	557,17711	**-3,23%**	267,36986	269,76781	**0,90%**
H Santarém	776,76543	754,06818	**-2,92%**	240,14504	224,94237	**-6,33%**
H Garcia de Orta	449,65766	442,23989	**-1,65%**	170,54214	177,7584	**4,23%**
H Fernando Fonseca	747,27457	735,39892	**-1,59%**	282,26747	282,7285	**0,16%**

CH Lisboa Central	242,13359	241,65546	**-0,20%**	108,74957	105,68109	**-2,82%**
CH Lisboa Ocidental	301,23904	301,90805	**0,22%**	122,44696	121,32102	**-0,92%**
CH São João	300,93317	302,32834	**0,46%**	122,81327	123,64352	**0,68%**
H Evora	261,15523	262,84083	**0,65%**	153,91489	148,36133	**-3,61%**
CH Barreiro	544,98842	551,68302	**1,23%**	248,94533	234,66453	**-5,74%**
ULS litoral alentejano	1064,8506	1079	**1,33%**	271,67742	279,15988	**2,75%**
CH Algarve	854,66829	871,1561	**1,93%**	241,99862	246,66713	**1,93%**
ULS castelo branco	304,62981	311,57407	**2,28%**	138,64989	146,62309	**5,75%**
CH Porto	132,32327	136,70695	**3,31%**	104,939	109,09567	**3,96%**
CH Coimbra	178,83796	184,8187	**3,34%**	107,11367	108,11046	**0,93%**
CH Médio Ave	606,11538	629,05797	**3,79%**	363,31988	370,98291	**2,11%**
ULS Guarda	394,29344	414,54297	**5,14%**	161,07571	159,10495	**-1,22%**
CH Médio Tejo	1237,8793	1304	**5,34%**	227,2057	218,25816	**-3,94%**
ULS Matosinhos	127,8339	135,62606	**6,10%**	99,109067	103,55943	**4,49%**
ULS North East	248,62376	265,68814	**6,86%**	124,93035	125,4048	**0,38%**
CH Lisboa Norte	149,07153	163,23677	**9,50%**	114,17543	122,49329	**7,29%**

Source: Health Portal

Bearing in mind that first consultations usually take around 30 minutes and subsequent consultations take around 15 minutes, assuming a (high) average of 20 minutes per consultation, each doctor used around 60 minutes per working day in consultations in 2015 and around 57 minutes in 2016.

The fall in productivity inherent in the administrative measure taken in 2016 to reduce the number of hours worked by health professionals to 35 hours is also visible in the fall in productivity in emergency departments, where doctors fell from an average of 485.8 in 2015 to an average of 478.14 in 2016 and nurses from an average of 210.27 in 2015 to an average of 209.11 in 2016.

Bearing in mind that emergency work is by its nature unscheduled, it makes no sense to extrapolate the average time that professionals devote to this activity.

Figure 14: Ratio of surgeries per doctor/nurse

	surgery/doctor ratio			surgery/nurse ratio		
	2015	2016	%	2015	2016	%
CH Povoa	40,738462	32,547771	**-20,11%**	24,86385	22,610619	**-9,06%**
H Barcelos	34,792308	29,616883	**-14,88%**	25,553672	26,212644	**2,58%**
ULS North East	25,19802	22,094915	**-12,31%**	12,661692	10,4288	**-17,64%**
CH Entre Douro e Vouga	71,082251	63,247059	**-11,02%**	30,691589	28,545133	**-6,99%**
CH Gaia Espinho	32,0191	28,811343	**-10,02%**	23,28373	21,797723	**-6,38%**
ULS Alto Minho	26,803681	25,031579	**-6,61%**	16,003663	15,995516	**-0,05%**
CH Leiria	43,59292	40,934605	**-6,10%**	20,243836	19,819261	**-2,10%**
H Figueira da Foz	88,454545	83,505882	**-5,59%**	35,659686	34,62439	**-2,90%**
CH São João	53,171583	50,551843	**-4,93%**	21,699754	20,674237	**-4,73%**
H Evora	50,685921	49,024221	**-3,28%**	29,87234	27,671875	**-7,37%**
CH Lisboa Ocidental	44,76494	43,348659	**-3,16%**	18,195951	17,419554	**-4,27%**
H Garcia de Orta	43,921922	42,727763	**-2,72%**	16,658314	17,174431	**3,10%**
ULS Matosinhos	11,211864	10,93401	**-2,48%**	8,6925099	8,3488372	**-3,95%**
CH Lisboa Central	36,471442	35,666667	**-2,21%**	16,380435	15,597795	**-4,78%**
CH Coimbra	27,467213	26,986826	**-1,75%**	16,451284	15,786055	**-4,04%**
CH Tondela Viseu	49,061053	48,207101	**-1,74%**	28,315917	29,027316	**2,51%**
CH Lisboa Norte	15,49711	15,254649	**-1,56%**	11,869397	11,447128	**-3,56%**
CH behind the hills	23,395928	23,032193	**-1,55%**	12,223404	12,676633	**3,71%**
CH Médio Ave	38,504808	38,338164	**-0,43%**	23,080692	22,609687	**-2,04%**
CH Algarve	33,380488	33,258537	**-0,37%**	9,4516575	9,4171271	**-0,37%**
ULS castelo branco	33,5625	33,444444	**-0,35%**	15,275711	15,738562	**3,03%**
CH Porto	17,179163	17,49667	**1,85%**	13,623938	13,962794	**2,49%**
H Santarém	40,419753	41,176136	**1,87%**	12,496183	12,283051	**-1,71%**
CH Barreiro	24,181467	25,230189	**4,34%**	11,045855	10,731942	**-2,84%**
ULS Guarda	29,405405	32,078125	**9,09%**	12,012618	12,311844	**2,49%**
CH Médio Tejo	81,155172	89,042373	**9,72%**	14,89557	14,903546	**0,05%**
H Fernando Fonseca	39,713873	54,03504	**36,06%**	15,001092	20,774093	**38,48%**
ULS litoral alentejano	34,609195	47,674157	**37,75%**	8,829912	12,334302	**39,69%**

Source: Health Portal

In the case of surgical activity, as with outpatient and emergency care, there was also a drop in average productivity between 2015 and 2016. Again, it doesn't make sense to extrapolate average times, as they vary considerably by speciality and pathology within the same speciality.

(D5)

In this dimension of analysis we will analyse the ratio between core operating costs and core production. We consider "core" operating costs to be staff costs, the cost of goods sold and materials consumed and external supplies and services, since in all cases in the sample considered these three cost items account for more than 90 per cent of total operating costs.

We consider "core" production to be the number of consultations carried out, emergency episodes attended and surgeries performed, as these three blocks of production are the most significant in terms of meeting care needs.

We consider "core" production to be the number of consultations carried out, emergency episodes attended and surgeries performed, as these three blocks of production are the most significant in terms of meeting care needs.

Reading this ratio is quite simple in the "core" context described above: the higher its value, the higher the unit cost per unit of production.

Figure 15: Core operating costs/core production ratio

	2015	2016	%
ULS litoral alentejano	311,17	297,13	**-4,51%**
CH Lisboa Norte	421,34	414,68	**-1,58%**
ULS castelo branco	388,82	383,16	**-1,46%**
H Santarém	273,76	272,85	**-0,33%**
CH Coimbra	970,46	968,82	**-0,17%**
ULS Matosinhos	331,13	331,49	**0,11%**
CH São João	317,55	319,95	**0,76%**
H Figueira da Foz	142,56	143,94	**0,97%**
H Fernando Fonseca	252,30	255,62	**1,32%**
H Garcia de Orta	301,55	305,75	**1,39%**
CH Leiria	189,75	193,12	**1,78%**
ULS Guarda	392,32	399,57	**1,85%**
H Barcelos	157,44	160,58	**1,99%**
CH Médio Ave	157,41	161,16	**2,38%**
H Evora	277,65	285,39	**2,79%**
CH Médio Tejo	234,67	242,02	**3,13%**
CH Algarve	260,23	268,48	**3,17%**

ULS Alto Minho	317,97	328,37	**3,27%**
CH Tondela Viseu	239,17	248,09	**3,73%**
CH Lisboa Ocidental	320,78	333,75	**4,04%**
CH behind the hills	240,04	251,30	**4,69%**
CH Gaia Espinho	240,53	252,75	**5,08%**
CH Porto	319,66	336,17	**5,16%**
ULS North East	442,74	466,06	**5,27%**
CH Barreiro	207,26	218,36	**5,36%**
CH Entre Douro e Vouga	160,86	170,93	**6,26%**
CH Lisboa Central	367,04	392,15	**6,84%**
CH Povoa	162,85	174,02	**6,86%**

Source: Health Portal

Reading this ratio is quite simple, in the "core" context described above, the higher its value, the higher the unit cost per unit of production, so, as you would expect, the average ratio increased from 299.97 to 306.27 from 2015 to 2016.

In the context of this work, it will be interesting to think about the impact that operational management measures focused on maximising productivity could have on the system as a whole and consequently on the financing of the system, allocating resources to pressing needs such as investment in preventive medicine, to the detriment of curative medicine, as well as highly differentiated and expensive curative medicine, typically referred to as "health innovation".

It should be noted that the issue of introducing rationality into health management is often misrepresented in the context of the irrationality and mediocrity of political discussion, in this case and in this work this concern is placed in the context of *value for money and* the inevitable rationality when we make collective choices.

In this context, we have drawn up two scenarios:

Figure 16: Results Scenario 1 and Scenario 2

	Scenario 1:			Scenario 2:		
	2015	2016	%	2015	2016	%
ULS litoral alentejano	374,96	297,13	**-20,76%**	329,96	297,13	**-9,95%**
CH Lisboa Norte	374,96	374,96	**0,00%**	329,96	329,96	**0,00%**
ULS castelo branco	374,96	374,96	**0,00%**	329,96	329,96	**0,00%**
H Santarém	273,76	272,85	**-0,33%**	273,76	272,85	**-0,33%**
CH Coimbra	374,96	374,96	**0,00%**	329,96	329,96	**0,00%**
ULS Matosinhos	374,96	374,96	**0,00%**	329,96	329,96	**0,00%**
CH São João	374,96	374,96	**0,00%**	329,96	329,96	**0,00%**
H Figueira da Foz	142,56	143,94	**0,97%**	142,56	143,94	**0,97%**
H Fernando Fonseca	252,30	255,62	**1,32%**	252,30	255,62	**1,32%**
H Garcia de Orta	374,96	374,96	**0,00%**	329,96	329,96	**0,00%**
CH Leiria	189,75	193,12	**1,78%**	189,75	193,12	**1,78%**
ULS Guarda	374,96	374,96	**0,00%**	329,96	329,96	**0,00%**
H Barcelos	157,44	160,58	**1,99%**	157,44	160,58	**1,99%**
CH Médio Ave	157,41	161,16	**2,38%**	157,41	161,16	**2,38%**
H Evora	277,65	285,39	**2,79%**	277,65	285,39	**2,79%**
CH Médio Tejo	234,67	242,02	**3,13%**	234,67	242,02	**3,13%**
CH Algarve	260,23	268,48	**3,17%**	260,23	268,48	**3,17%**
ULS Alto Minho	374,96	374,96	**0,00%**	329,96	329,96	**0,00%**
CH Tondela Viseu	239,17	248,09	**3,73%**	239,17	248,09	**3,73%**
CH Lisboa Ocidental	374,96	374,96	**0,00%**	329,96	329,96	**0,00%**
CH behind the hills	240,04	251,30	**4,69%**	240,04	251,30	**4,69%**
CH Gaia Espinho	240,53	252,75	**5,08%**	240,53	252,75	**5,08%**
CH Porto	374,96	374,96	**0,00%**	329,96	329,96	**0,00%**
ULS North East	374,96	374,96	**0,00%**	329,96	329,96	**0,00%**
CH Barreiro	207,26	218,36	**5,36%**	207,26	218,36	**5,36%**
CH Entre Douro e Vouga	160,86	170,93	**6,26%**	160,86	170,93	**6,26%**
CH Lisboa Central	374,96	374,96	**0,00%**	329,96	329,96	**0,00%**
CH Povoa	162,85	174,02	**6,86%**	162,85	174,02	**6,86%**

Source: Health Portal

Scenario 1: In this scenario we consider that the hospitals with the worst performance in this operational performance ratio would have performances 25 per cent lower than the average values;

Scenario 2: In this scenario we consider that the hospitals with the worst performance in this operational performance ratio would have performances that are 10 per cent lower than the average values.

Thus, based on the assumptions of the scenarios presented, we would objectively have the possibility of improving performance in 2015 by 4 per cent (C1) and 7 per cent (C2), as well as in 2016 by 6 per cent (C1) and 7 per cent (C2).

Considering the year 2016 alone, we would be talking about potential savings of between 6% and 7% by reducing the correlation coefficient between the current performance of the EPE Hospitals, but without taking fundamental structural measures or changing the current management paradigm, which is highly politicised and constantly under pressure from the various unions that make up the sector.

(D6)

With regard to staff costs, typically the most important item in a hospital's operating costs, usually more than 50 per cent of total costs, we created a ratio that relates (total) staff costs to the number of doctors and nurses, as essential FTEs for carrying out the care activity, because not only due to the (lack of) quality of the financial statements, it didn't seem possible to determine a percentage of *overhead costs*.

A priori, one would expect the higher ratios to represent the more differentiated hospitals, not only in terms of quantity but also in terms of the number of clinical staff, but this was not the case.

When we analyse the evolution between 2015 and 2016, we naturally see an increase in this ratio due to the increase in personnel costs, but it is curious that we notice a greater increase in the professional group of nurses with a lower standard deviation than the professional group of doctors.

This data confirms what we know from simply analysing the variation in the number of professionals, namely that between 2015 and 2016 there was a significant investment in

hiring in general, but more prominently in the hiring of nurses, greater than the effort to hire doctors and with more similar salary conditions.

It should be noted that this "statistical similarity" as a result of the lower standard deviation typically indicates a pattern of collective bargaining, as was indeed the case.

Figure 17: Staff / professional cost ratios

	ccp/n professionals ratio			ccp/n doctors ratio			ccp/n nurses ratio		
	2015	2016	%	2015	2016	%	2015	2016	%
H Barcelos	39 876,29	40 522,93	**1,62%**	94 169,40	86 308,57	**-8,35%**	69 163,96	76 388,04	**10,44%**
CH Leiria	46 725,12	47 523,47	**1,71%**	147 342,63	145 678,21	**-1,13%**	68 423,49	70 532,85	**3,08%**
H F Fonseca	46 631,54	48 907,14	**4,88%**	170 083,84	176 118,42	**3,55%**	64 245,64	67 709,78	**5,39%**
CH Gaia Espinho	51 863,94	49 067,94	**-5,39%**	123 185,70	113 923,94	**-7,52%**	89 578,49	86 191,15	**-3,78%**
CH Tondela Viseu	50 255,35	50 508,24	**0,50%**	137 329,37	134 389,77	**-2,14%**	79 260,57	80 921,16	**2,10%**
CH Povoa	50 720,82	50 691,77	**-0,06%**	133 824,92	123 662,10	**-7,59%**	81 677,18	85 906,85	**5,18%**
CH T hills	51 931,57	51 401,49	**-1,02%**	151 330,01	144 792,93	**-4,32%**	79 063,67	79 692,23	**0,80%**
CH Barreiro	51 855,68	51 742,94	**-0,22%**	165 377,57	173 387,67	**4,84%**	75 542,84	73 752,38	**-2,37%**
CH Coimbra	51 389,00	52 005,80	**1,20%**	137 188,55	140 911,57	**2,71%**	82 168,07	82 426,80	**0,31%**
ULS Matosinhos	50 271,95	52 149,13	**3,73%**	115 114,24	120 445,96	**4,63%**	89 247,57	91 968,43	**3,05%**
CH Lisboa Norte	53 107,18	54 169,89	**2,00%**	122 445,81	126 357,65	**3,19%**	93 782,51	94 819,11	**1,11%**
H Evora	55 762,03	54 589,30	**-2,10%**	150 376,32	151 301,13	**0,61%**	88 626,04	85 402,39	**-3,64%**
ULS Alto Minho	56 377,02	54 591,74	**-3,17%**	150 799,88	140 023,03	**-7,15%**	90 038,02	89 476,60	**-0,62%**
CH Médio Ave	53 666,55	54 836,23	**2,18%**	143 196,82	147 819,40	**3,23%**	85 835,56	87 175,54	**1,56%**
CH Porto	52 156,34	55 352,96	**6,13%**	117 923,11	124 715,33	**5,76%**	93 518,94	99 526,05	**6,42%**
CH São João	55 172,93	55 975,58	**1,45%**	190 364,88	192 844,92	**1,30%**	77 689,45	78 867,97	**1,52%**
H Santarém	57 967,22	56 119,35	**-3,19%**	245 466,13	244 246,70	**-0,50%**	75 888,38	72 860,03	**-3,99%**
CH Médio Tejo	58 560,20	56 653,16	**-3,26%**	377 612,32	395 131,75	**4,64%**	69 308,59	66 135,53	**-4,58%**
ULS Guarda	57 315,38	57 687,90	**0,65%**	197 616,35	207 991,93	**5,25%**	80 729,71	79 828,99	**-1,12%**
ULS Lit.Alentej.	54 396,79	57 841,77	**6,33%**	267 607,19	281 409,96	**5,16%**	68 275,15	72 806,65	**6,64%**
H Garcia de Orta	57 967,83	57 897,27	**-0,12%**	210 807,95	201 938,20	**-4,21%**	79 953,36	81 169,09	**1,52%**
ULS C white	56 552,27	58 190,44	**2,90%**	180 804,13	181 845,13	**0,58%**	82 291,60	85 574,18	**3,99%**
CH Algarve	56 276,95	58 592,30	**4,11%**	255 030,67	265 523,14	**4,11%**	72 211,72	75 182,66	**4,11%**
CH Lisboa Oc.	58 178,32	58 722,12	**0,93%**	201 306,27	204 852,45	**1,76%**	81 826,51	82 319,46	**0,60%**
CH Lisboa Central	60 933,85	60 150,79	**-1,29%**	196 604,58	197 694,49	**0,55%**	88 301,10	86 456,02	**-2,09%**
H Figueira da Foz	62 267,28	61 467,40	**-1,28%**	216 722,49	209 712,29	**-3,23%**	87 369,80	86 953,88	**-0,48%**
ULS North East	59 205,30	62 176,09	**5,02%**	177 029,70	193 905,08	**9,53%**	88 955,22	91 523,20	**2,89%**
CH Douro Vouga	61 207,79	62 326,16	**1,83%**	202 966,10	200 421,37	**-1,25%**	87 635,83	90 455,66	**3,22%**

Source: Health Portal

7.5. Descriptive statistics

Finally, in terms of the **descriptive statistics of the data,** we will analyse the various statistical elements (number of observations, maximum, minimum, mean, median and standard deviation) for each of the years under analysis and by variable, by type of "group" considered in this analysis. We will also analyse the variation between the various years under analysis (delta %) to try to identify the relative size of the variations between the various statistical elements over the years.

Year 2015:

Inputs:	# doctors	# nurses	capacity	ccp	cmvmc	fse
Sample	28,00	28,00	28,00	28,00	28,00	28,00
Maximum	1586,00	2648,00	1826,00	217581038,00	170371524,27	63389952,53
Minimum	77,00	177,00	117,00	12242021,55	3087669,00	2994382,43
Median	336,00	745,50	402,50	56244503,50	21900958,00	20611867,50
Average	463,09	901,43	566,75	74099872,52	45094037,92	23903265,23
standard deviation	388,66	634,91	395,74	54613140,94	49008716,22	14670517,19
% standard deviation/average	-16%	-30%	-30%	-26%	9%	-39%

Outputs	number of outpatient appointments	ep urgency number	number of surgeries
Sample	28,00	28,00	28,00
Maximum	775501,00	350414,00	44159,00
Minimum	64625,00	63363,00	3011,00
Median	245568,50	146665,00	13396,50
Average	288302,68	154323,71	15114,11
standard deviation	211232,02	73954,72	11126,65
% standard deviation/average	-27%	-52%	-26%

Year 2016:

Inputs	# doctors	# nurses	capacity	ccp	cmvmc	fse
Sample	28,00	28,00	28,00	28,00	28,00	28,00
Maximum	1594,00	2725,00	1808,00	224613038,00	170872343,54	61129529,31
Minimum	85,00	174,00	117,00	13291519,71	3067681,00	3108220,73
Median	369,00	766,00	397,50	61270967,50	22069916,64	20708625,00
Average	486,21	945,30	567,89	78457102,23	46964657,33	24363973,95
standard deviation	395,60	658,37	393,81	56779765,42	50893509,99	14317465,43
% standard deviation/average	-19%	-30%	-31%	-28%	8%	-41%

Outputs	number of outpatient appointments	ep urgency number	number of surgeries
Sample	28,00	28,00	28,00
maximum	751380,00	357174,00	43879,00
minimum	71312,00	67300,00	4243,00
median	249777,00	155734,00	13902,00
Average	290739,57	161350,07	15683,75
standard deviation	210139,42	76651,49	11088,15
% standard deviation/average	-28%	-52%	-29%

Delta 2016/2015:

Inputs	# doctors	# nurses	capacity	ccp	cmvmc	fse
Sample	0%	0%	0%	0%	0%	0%
Maximum	1%	3%	-1%	3%	0%	-4%
Minimum	10%	-2%	0%	9%	-1%	4%
Median	10%	3%	-1%	9%	1%	0%
Average	5%	5%	0%	6%	4%	2%
standard deviation	2%	4%	0%	4%	4%	-2%
% standard deviation/average	16%	3%	2%	5%	-4%	7%

Outputs	number of outpatient appointments	ep urgency number	number of surgeries
Sample	0%	0%	0%
maximum	-3%	2%	-1%
minimum	10%	6%	41%
median	2%	6%	4%
average	1%	5%	4%
standard deviation	-1%	4%	0%
% standard deviation/average	4%	1%	11%

An analysis of the data shows a very significant increase in the minimum number of surgeries and the number of outpatient consultations, naturally due to the aforementioned measures that resulted in a reduction in productivity in the sector.

This situation was less visible in the number of emergency episodes, which demonstrates not only greater care in the management of this area of production, but

also the "hospital-centric" nature of our NHS, which clearly favours the use of hospital emergencies over alternative solutions in primary health care.

In descriptive statistics, Pearson's correlation coefficient, or product-moment correlation, measures the degree of correlation between two variables on a metric scale. In the figure below we present the correlation coefficients between all the variables considered in this model, with a view to checking their level of association and between the various levels of association to see whether or not we have managed to capture a rationale that guarantees us some comfort in testing these variables in the models we will present below.

Figure 18: Correlation Coefficient

	# doctors	# nurses	capacity	ccp	cmvmc	fse	# ext. enquiries	# ep urgency	# surgeries
# doctors	1	0,90	0,871	0,936	0,930	0,827	0,666	0,564	0,788
# nurses		1	0,969	0,989	0,931	0,898	0,693	0,769	0,898
capacity			1	0,946	0,894	0,870	0,599	0,816	0,880
Ccp				1	0,953	0,892	0,726	0,703	0,877
cmvmc					1	0,825	0,788	0,632	0,834
Fse						1	0,549	0,686	0,736
# ext. enquiries							1	0,530	0,667
# ep urgency								1	0,690
# surgeries									1

Source: Health Portal

It should be noted that when the co-correlation coefficient is greater than 0.9 we have very strong co-correlation, when it is between 0.7 and 0.9 we have strong co-correlation and when it is between 0.5 and 0.7 we have moderate co-correlation.

By analysing the figures above, we can see that the variables show a very strong correlation in 22% of cases, a strong correlation in 50% of cases and a moderate correlation in 28% of cases.

Thus, in 72 per cent of cases the variables have a strong or very strong correlation, which guarantees the necessary robustness to the underlying statistical analysis, as the aforementioned authors had already concluded.

In this sense, and in a very favourable context of co-relation between the variables, the use of DEA and SFA models seems perfectly feasible in order to rationalise this operational risk management model, based on efficiency analysis.

Chapter 8 - Research Hypothesis

8.1 Research Hypothesis I

8.1.1 Objective

As mentioned above, in this hypothesis we will try to see if there is a cause-effect analysis between the resources available in the EPE Hospitals and the healthcare results.

Then, on the basis of the relational patterns verified, we will try to validate whether or not there is a rational relationship between the factors, or whether there is a cause-effect relationship between the input and output variables.

This rational relationship between the factors can be determined on the one hand by checking the cause-effect relationship and, if such a relationship exists, by trying to understand the marginal variation of the variables.

8.1.2 Data and variables

With regard to the data and variables, following the literature review above, we considered the number of doctors, number of nurses, capacity, staff costs, costs of goods sold and materials consumed, supplies and external services as input variables, and the number of outpatient consultations, number of emergency episodes and number of surgeries as output variables.

As we can see above in Figure 18, these variables have a very acceptable level of correlation and, in this sense, represent what is essential to a hospital's care performance, because without any of the inputs it is not possible to carry out care activities.

On the other hand, since it is a common feature of all hospitals, all the above inputs will be used differently, not only depending on the management model underlying hospital management, but also on their specific characteristics.

It's important to note at this point that all the data available was taken from the reports and accounts of the hospitals in question for the years indicated, which was an absolutely daunting task, not only because of the reports' lack of quality in terms of both form and content.

In terms of form, we found a "free will" in the presentation of accounts by each Board of Directors, which means that the twenty-eight entities included in this analysis produce twenty-eight differently organised accounts reports, i.e. in order to obtain the apparently simple data considered in this work, a lot of work was needed to analyse and collect information, also because some elements of the financial statements presented in the reports are at the limit of legible information.

In terms of content, it can be seen that each Board of Directors emphasises the topics it prefers, in a completely arbitrary way, but with a criterion for choosing topics that is almost propagandistic in tone.

Naturally, this question only arises because the Ministry of Health does not impose qualitative standards for the presentation of accounts, which unequivocally places the financial information of healthcare organisations in a state of obscurity.

It was also interesting to see that in some cases the organisations changed the form of their financial statements during the two-year period, which clearly demonstrates the effort made to obtain the database to support this work.

The lack of transparency described above, or the lack of competence of the ministers in charge, or the lack of competence of the state's control mechanisms, or the lack of civic culture on the part of citizens as funders and beneficiaries of the system, or perhaps all of the above, have resulted in it still not being possible at the end of 2018 to obtain the 2017 financial statements for the entire universe of twenty-eight hospitals considered in this work, which would naturally make it possible to analyse a three-year period in this work and thus improve the grounds for the conclusions presented here.

In this context, we analysed the aforementioned inputs and outputs in the context of DEA and SFA estimations, using the DEAP and FRONTIER models for the 28 hospitals in 2015 and 2016.

8.1.3 Application of the model

Based on the above hypotheses, various estimations will be carried out using the methodological approach of the data envelopment analysis (DEA) efficiency frontier with the aim of calculating the efficient production frontier and from this frontier analysing the behaviour of the twenty-eight hospitals considered in the sample.

These efficiency frontiers have been estimated using very different methods and techniques over the last 40 years, with data envelopment analysis (DEA) and stochastic frontiers (SFA) being the two main methods in use.

These methods involve mathematical programming and econometric methods, and in this work they were estimated using the DEAP and FRONTIER software mentioned above. This was also a challenge within the scope of this research work: to know, use and interpret the results of the outputs generated by these two information systems.

The "modern" efficiency calculations had Farrel (1957) as a precursor who developed the work of Debreu (1951) and Koopmans (1951) to define a simple measure of efficiency that considered multiple inputs.

Farrel distinguished between technical efficiency, as the possibility of obtaining a maximum of outputs for a quantity of inputs, and allocative efficiency, which reflects the possibility of a company optimising the use of inputs, taking into account the respective prices.

These two measures combined therefore result in total economic efficiency.
Next, we have to distinguish between input-orientated efficiency measures and output-orientated efficiency measures.

Input-orientated efficiency measures aim to identify how many units of inputs can be proportionally reduced without changing the quantities of outputs produced.

Output-orientated efficiency measures aim to identify how many additional units of output can be proportionally produced without changing the quantities of inputs produced.

Data envelopment analysis (DEA) is therefore a non-parametric approach to mathematical programming aimed at estimating the optimal production frontier, which has been thoroughly tested and therefore has the conceptual stability needed to be considered as a proxy in operational risk management models in healthcare units with a management model as described above.

The revision and validation of these models were greatly developed in the 1990s by Seiford and Thall (1990), Lovell (1993), Ali and Seiford (1993), Lovell (1994), Charnes et al (1995) and Seiford.

In Portugal, one of the authors who uses this approach is Pedro Pitta Barros, one of the Portuguese specialists in health economics. In this work, the novelty we are trying to introduce will be to use this methodology as a *proxy* for a KPI in the context of an operational risk management model.

The reasonableness of this approach is verified by the fact that the government is studying the possibility of introducing efficiency criteria to measure EPE Hospitals in the near future.

In the context of research hypothesis no. 1, we are going to apply this method to **analyse** the **overall** cause-effect relationship between available resources and healthcare results, carrying out various tests.

At DEA level, we used the following battery of tests, and then for almost all of the domains listed below in I) II) and III) we carried out a comparative analysis of the results between input-oriented and output-oriented efficiency analyses.

We therefore sought to obtain a holistic view of these efficiency results for the EPE hospitals we considered in our sample.

I) DEA - one input vs one output (1x1):

- Doctors vs consultations in 2015;
- Doctors vs consultations in 2016;
- Nurses vs consultations in 2015;
- Nurses vs consultations in 2016.

II) DEA - two inputs vs two outputs (2x2):

- doctors and nurses vs consultations and surgeries in 2015;
- doctors and nurses vs consultations and surgeries in 2016.

II) DEA - six inputs vs one output (6x1):

- all inputs vs consultations 2015;
- all inputs vs consultations 2016;
- all inputs vs urgencia 2015;
- all inputs vs urgencia 2016;
- all inputs vs surgeries 2015;
- all inputs vs surgeries 2016.

The results will then be presented based on the association of a code with an EPE Hospital, as described in the following figure:

Figure 19: Code of the EPE hospitals considered in the sample

# Code	EPE Hospital:
1	CH Algarve
2	CH Barreiro
3	CH Coimbra
4	CH Entre Douro e Vouga
5	CH Gaia Espinho
6	CH Leiria
7	CH Lisboa Central
8	CH Lisboa Norte
9	CH Lisboa Ocidental
10	CH Médio Ave
11	CH Médio Tejo
12	CH Porto
13	CH Povoa
14	CH São João
15	CH Tondela Viseu
16	CH behind the hills
17	H Barcelos
18	H Évora
19	H Fernando Fonseca
20	H Figueira da Foz
21	H Garcia de Orta
22	H Santarém
23	ULS Alto Minho
24	ULS Castelo Branco
25	ULS Guarda
26	ULS Litoral Alentejano
27	ULS Matosinhos
28	ULS Northeast

Source: Own elaboration

The stochastic production frontier was originally proposed by Aigner, Lovell and Schmidt (1977) and Meeuseen and Van Den Broek (1977) involving the original specification of a production function for information from various sources that included an error with two components, a random component and a technical inefficiency component.

This original specification has been used in various empirical studies in recent years and the specifications have been altered and extended in various ways, and also in the 1980s

and 1990s were developed by the following authors Forsund, Lovell and Schmidt (1980), Schmidt (1980), Bauer (1990) and Greene (1993).

Frontier software was used to obtain maximum likelihood estimates of stochastic production frontiers and cost functions, in line with all the aforementioned authors. In Portugal, Pedro Pitta Barros also uses this methodology in his research work.

At the CSS level, we also carried out a battery of tests using the following production factors to obtain the following results:

I) SFA - two productive factors vs. one output (2x1):

- doctors and consultations vs consultations 2015;
- personnel costs and cost of goods sold vs. consultations 2015;

- doctors and consultations vs consultations 2016;
- personnel costs and cost of goods sold vs. 2016 consultations;

- doctors and consultations vs emergencies 2015;
- staff costs and cost of goods sold vs emergency 2015;

- doctors and consultations vs emergency 2016;
- staff costs and cost of goods sold vs emergency 2016;

- doctors and consultations vs surgeries 2015;
- staff costs and cost of goods sold vs surgeries 2015;

- doctors and consultations vs surgeries 2016;
- staff costs and cost of goods sold vs surgeries 2016;

We will also use the coding described in Figure 19 above at CSS level.

8.1.4 Analysing Results

Following on from the estimations, we used a programme developed by Tim Coelli (PhD), a professor at the Australian University of New England, namely the DEAP programme which involves the data envelopment analysis (DEA) methodology based on Malmquist indices.

We also used the FRONTIER program, which involves the Stochastic Frontier Analysis (SFA) methodology through the estimation of transcendental logarithmic functions (translog) where operating costs were analysed as a function of output variables.

AED (1x1) Doctors vs Consultations 2015

```
EFFICIENCY SUMMARY:

 firm     te
   1  0.562
   2  0.506
   3  0.049
   4  0.878
   5  0.459
   6  0.501
   7  0.502
   8  0.338
   9  0.615
  10  0.535
  11  1.000
  12  0.435
  13  0.411
  14  0.593
  15  0.362
  16  0.456
  17  0.353
  18  0.501
  19  0.599
  20  0.805
  21  0.597
  22  0.606
  23  0.324
  24  0.307
  25  0.338
  26  0.496
  27  0.304
  28  0.244

mean  0.489
```

In 2015, based on a rationale (1x1), we see that the efficiency between doctors and consultations in 2015 is on average 0.489, which is low and very far from the efficiency frontier.

In this regard, the EPE hospital with the best performance is the Médio Tejo Hospital Centre, which reaches the efficiency frontier (score 1), and the worst performance is the Coimbra Hospital Centre (score 0.049).

Also noteworthy was the positive performance of Centro Hospitalar entre Douro e Vouga and Hospital da Figueira da Foz and the less positive performance of ULS Matosinhos and ULS Nordeste.

(1x1) Doctors vs Consultations 2016

```
EFFICIENCY SUMMARY:

 firm     te
    1  0.557
    2  0.501
    3  0.050
    4  0.768
    5  0.396
    6  0.457
    7  0.464
    8  0.332
    9  0.585
   10  0.503
   11  1.000
   12  0.424
   13  0.348
   14  0.569
   15  0.343
   16  0.400
   17  0.306
   18  0.474
   19  0.584
   20  0.743
   21  0.530
   22  0.559
   23  0.285
   24  0.297
   25  0.345
   26  0.567
   27  0.312
   28  0.241

mean  0.462
```

Based on the same rationale (1x1), in 2016 we can see that the efficiency between doctors and consultations is on average 0.462, i.e. it has worsened compared to 2015 and is even lower and very far from the efficiency frontier.

In this regard, the EPE hospital with the best performance remains the Médio Tejo Hospital Centre, which reaches the efficiency frontier (score 1), and the worst performance is seen in the Coimbra Hospital Centre (score 0.050).

The positive performance of Centro Hospitalar entre Douro e Vouga and Hospital da Figueira da Foz and the less positive performance of ULS Matosinhos and ULS Nordeste stand out, but all of them consistently worsened their performance compared to the same period last year.

In this test, we evaluate the input "doctor" and the output "consultations" from the input perspective: *"How many units of inputs can be proportionally reduced without changing the quantities of outputs produced?"*

In 2016, taking into account that the EPE hospitals with the highest number of doctors are CH Coimbra (score 0.050), CH Lisboa Central (score 0.464) and CH Porto (score 0.424), it can be seen that in this case:

Conclusion 1: When we relate doctors and consultations, there is no cause-and-effect relationship between the resources available at the EPE Hospitals and the healthcare results.

From an empirical point of view, the results make sense because the hospitals with the most doctors are also university hospitals, i.e. this conclusion allows us to conclude that, in these terms, there is no cause-effect relationship between the resources available in the hospitals and the care results seen, and it also illustrates the need to determine and remunerate the value of the training hours dedicated by these institutions to training professionals, for which no right of return is required when medical professionals leave the EPE Hospitals for the private sector and/or abroad.

This situation is one of the sources of inequality between public and private healthcare provision, since private hospitals do not have a training nature and therefore all the costs associated with this process.

We will also analyse the number of nurses and the number of consultations in order to compare them with the above analysis and see if the efficiency scores show the same behaviour in the universe of EPE hospitals considered in this research.

Naturally, the majority of consultations are carried out by doctors, but there are consultations for certain specialities carried out by nurses, and there are a considerable number of nursing professionals allocated to consultation support activities, so this efficiency analysis may make sense.

(1x1) Nurses vs Consultations 2015

```
EFFICIENCY SUMMARY:

 firm     te
   1  0.420
   2  0.610
   3  0.078
   4  1.000
   5  0.881
   6  0.614
   7  0.595
   8  0.684
   9  0.660
  10  0.847
  11  0.484
  12  0.910
  13  0.663
  14  0.640
  15  0.551
  16  0.629
  17  0.684
  18  0.779
  19  0.598
  20  0.857
  21  0.597
  22  0.495
  23  0.510
  24  0.369
  25  0.365
  26  0.334
  27  0.623
  28  0.324

mean  0.600
```

In 2015, based on a rationale (1x1), we can see that the efficiency between nurses and consultations is on average 0.600, i.e. it has an average value not far from the efficiency frontier. This average score is higher than the value recorded in the same analysis for doctors and consultations.

In this case, the EPE hospital with the best performance is the Centro Hospitalar entre Douro e Vouga, which reaches the efficiency frontier (score 1), and the worst performance is the ULS Nordeste (score 0.324).

Also noteworthy was the positive performance of Centro Hospitalar Gaia Espinho, Centro Hospitalar do Porto and Hospital da Figueira da Foz and the less positive performance of ULS Litoral Alentejano and ULS da Guarda.

AED (1x1) Nurses vs Consultations 2016

```
EFFICIENCY SUMMARY:

 firm     te
    1  0.455
    2  0.615
    3  0.085
    4  1.000
    5  0.864
    6  0.639
    7  0.585
    8  0.719
    9  0.678
   10  0.856
   11  0.483
   12  0.977
   13  0.697
   14  0.672
   15  0.597
   16  0.635
   17  0.782
   18  0.772
   19  0.648
   20  0.888
   21  0.614
   22  0.481
   23  0.526
   24  0.404
   25  0.383
   26  0.423
   27  0.687
   28  0.328

 mean  0.625
```

In 2016, based on a rationale (1x1), we can see that the efficiency between nurses and consultations is on average 0.625, i.e. an average value not far from the efficiency frontier.

This average score is higher than the value recorded in the same analysis between doctors and consultations and showed an inverse evolution, i.e. the efficiency ratio between nurses and consultations improved between 2015 and 2016.

The EPE hospital with the best performance remains the Centro Hospitalar entre Douro e Vouga, which reaches the efficiency frontier (score 1), and the worst performance is seen by the ULS Nordeste, which is still improving on 2015 (score 0.328). As for the

EPE hospitals with positive and negative highlights mentioned above, namely Centro Hospitalar Gaia Espinho, Centro Hospitalar do Porto, Hospital da Figueira da Foz, ULS Litoral Alentejano and ULS da Guarda in all cases improved their efficiency scores from 2015 to 2016. In this test, we evaluate the input "nurse" and the output "consultations" from the input perspective: *"How many units of inputs can be proportionally reduced without changing the quantities of outputs produced?"*

In 2016, taking into account that the EPE hospitals with the highest number of nurses are CH Coimbra (score 0.085), CH Lisboa Central (score 0.585) and CH São João (score 0.672), it can be seen that in this case:

Conclusion 2: When we relate nurses and consultations, there is no cause-and-effect relationship between the resources available at the EPE Hospitals and the care results seen.

Thus, according to conclusions C1 and C2, when we relate an input to an output (1x1) we see that there is no cause-and-effect relationship between the resources available at the EPE Hospitals and the healthcare results.

AED (2x2) Doctors and Nurses vs Consultations and Surgeries 2015

EFFICIENCY SUMMARY:

firm	te
1	0.608
2	0.610
3	0.461
4	1.000
5	0.881
6	0.636
7	0.595
8	0.684
9	0.697
10	0.847
11	1.000
12	0.910
13	0.732
14	0.692
15	0.794
16	0.629
17	0.754
18	0.870
19	0.673
20	1.000
21	0.671
22	0.664
23	0.515
24	0.429
25	0.391
26	0.528
27	0.623
28	0.366
mean	0.688

In 2015, based on a rationale (2x2), we can see that the efficiency between doctors, nurses and consultations, surgeries in 2015 is on average 0.688, i.e. an average value in relation to the efficiency frontier. In this regard, the EPE hospitals with the best performance are Centro Hospitalar Médio Tejo and Hospital Fernando da Fonseca, which reach the efficiency frontier (score 1), and the worst performance is seen in ULS do Nordeste (score 0.366).

Also noteworthy is the positive performance of the Porto Hospital Centre and the Évora Hospital and the less positive performance of the Guarda ULS.

AED (2x2) Doctors and Nurses vs Consultations and Surgeries 2016

```
EFFICIENCY SUMMARY:

 firm     te
   1  0.656
   2  0.646
   3  0.456
   4  1.000
   5  0.864
   6  0.658
   7  0.601
   8  0.719
   9  0.745
  10  0.856
  11  1.000
  12  0.977
  13  0.730
  14  0.735
  15  0.838
  16  0.635
  17  0.829
  18  0.840
  19  0.749
  20  1.000
  21  0.675
  22  0.667
  23  0.538
  24  0.455
  25  0.443
  26  0.652
  27  0.687
  28  0.341

mean  0.714
```

In 2016, based on a (2x2) rationale, we can see that the efficiency between nurses and consultations is on average 0.714, i.e. an average value not far from the efficiency frontier. This average score is higher than the value recorded in the same analysis among doctors, nurses and consultations, surgeries and recorded a positive evolution in efficiency compared to the values recorded in 2015.

In 2016, when we look at the EPE hospitals with the best performance, we add the Figueira da Foz Hospital to the Médio Tejo Hospital Centre and the Fernando da Fonseca Hospital (score 1), and the worst performance remains that of the ULS Nordeste, which still improved on 2015 (score 0.341).

As for the positive and negative EPE Hospitals mentioned above, in all cases they improved their efficiency score from 2015 to 2016.

In this test, we evaluate the input "nurse" and the output "consultations" from the input perspective: *"How many units of inputs can be proportionally reduced without changing the quantities of outputs produced?"*

In 2016, if we consider the EPE Hospitals with the most significant number of doctors and nurses, we identify CH Coimbra (score 0.466), CH Lisboa Central (score 0.708), CH Lisboa Norte (score 0.719).

Conclusion 3: When we relate doctors and nurses to consultations and surgeries, there is no cause-and-effect relationship between the resources available at EPE Hospitals and the healthcare results.

It should be noted that CH do Porto has a very high efficiency score (0.977), but it still

```
Results for firm:    12
Technical efficiency = 0.977
 PROJECTION SUMMARY:
  variable          original       radial        slack     projected
                       value     movement     movement         value
 output     1     674533.000        0.000        0.000   674533.000
 output     2      18389.000        0.000    18344.077    36733.077
 input      1       1051.000      -24.067     -446.146      580.787
 input      2       1317.000      -30.158        0.000     1286.842
 LISTING OF PEERS:
  peer   lambda weight
    4      2.278
```

doesn't reach the level of the best performers in this efficiency analysis.

AED (2x2) Doctors and Nurses vs Consultations and Surgeries 2016 - Figueira da Foz Hospital

```
Results for firm:    20
Technical efficiency = 1.000
 PROJECTION SUMMARY:
  variable           original        radial         slack     projected
                        value      movement      movement         value
 output     1       95466.000         0.000         0.000     95466.000
 output     2        7098.000         0.000         0.000      7098.000
 input      1          85.000         0.000         0.000        85.000
 input      2         205.000         0.000         0.000       205.000
 LISTING OF PEERS:
  peer   lambda weight
   20      1.000
```

If we compare the performance of Centro Hospitalar do Porto (score 0.977) with Hospital da Figueira da Foz (score 1), we see that the inefficiency lies in the inputs of doctors and nurses and the output of surgeries.

(6x1) Doctors, Nurses, Capacity, Staff Costs, Cost of Goods Sold and Materials Consumed and External Supplies and Services vs Consultations 2015

```
EFFICIENCY SUMMARY:

 firm     te
   1  0.625
   2  0.739
   3  0.084
   4  1.000
   5  1.000
   6  0.794
   7  0.726
   8  0.738
   9  0.763
  10  1.000
  11  1.000
  12  1.000
  13  1.000
  14  0.868
  15  0.642
  16  0.697
  17  0.866
  18  0.809
  19  0.815
  20  1.000
  21  0.711
  22  0.668
  23  0.783
  24  0.538
  25  0.575
  26  0.669
  27  0.926
  28  0.497

mean  0.769
```

In 2015, based on a (6x1) rationale, we can see that the efficiency between all the productive factors and consultations is on average 0.769, i.e. a reasonable value not far from the efficiency frontier.

This will be the most relevant efficiency test since it includes all the factors of production that we considered in this study, which have been widely validated as mentioned above and are totally decisive for hospital production, namely doctors, nurses, staffing, staff costs, costs of goods sold and materials consumed and external supplies and services.

It should be noted that in the reality of the EPE hospital universe, "contractors" are often used, i.e. doctors and specialised staff (nurses and technicians) who are outsourced, with the inherent costs being recorded as external supplies and services, but these are resources that are absolutely decisive for achieving care outputs.

In the context of this analysis, the EPE Hospitals that perform efficiently (score 1) are the following:

- Entre Douro e Vouga Hospital Centre;
- Gaia Espinho Hospital Centre;
- Médio Ave Hospital Centre;
- Médio Tejo Hospital Centre;
- Porto Hospital Centre;
- Povoa Hospital Centre;
- Figueira da Foz Hospital.

On the other hand, the EPE Hospitals that perform less efficiently are the following:

- ULS Castelo Branco (score 0.538);
- ULS Guarda (score 0.575);

- ULS Nordeste (score 0.479).

AED (6x1) Doctors, Nurses, Capacity, Staff Costs, Cost of Goods Sold and Materials Consumed and External Supplies and Services vs Consultations 2016

EFFICIENCY SUMMARY:

firm	te
1	0.673
2	0.764
3	0.093
4	1.000
5	1.000
6	0.830
7	0.738
8	0.753
9	0.766
10	1.000
11	1.000
12	1.000
13	1.000
14	0.907
15	0.672
16	0.721
17	0.926
18	0.842
19	0.865
20	1.000
21	0.704
22	0.681
23	0.826
24	0.605
25	0.588
26	0.774
27	0.966
28	0.468
mean	0.791

In 2016, based on a (6x1) rationale, we can see that the efficiency between all the productive factors and consultations is on average 0.791, which is a reasonable value not far from the efficiency frontier and better than in 2015, i.e. there was an increase in efficiency between 2015 and 2016.

Taking into account the scope of this test, there has been a positive evolution in hospital efficiency, which was certainly interrupted in 2017 due to the administrative decision to implement the 35-hour week. In the context of this analysis, in 2016 the EPE Hospitals that perform efficiently (score 1) remain the following:

- Entre Douro e Vouga Hospital Centre;
- Gaia Espinho Hospital Centre;
- Médio Ave Hospital Centre;
- Médio Tejo Hospital Centre;
- Porto Hospital Centre;

- Povoa Hospital Centre;
- Figueira da Foz Hospital.

On the other hand, the EPE Hospitals that perform less efficiently remain the following:
- ULS Castelo Branco (score 0.605);
- ULS Guarda (score 0.588);
- ULS Nordeste (score 0.468).

There is therefore an improvement in efficiency in the worst performers. In 2016, if we consider the EPE Hospitals that have the most significant volume in terms of doctors, nurses, as well as the operating costs considered in this study, namely staff costs, cost of goods sold and materials consumed and external supplies and services, we identify CH Coimbra score (0.093), CH Lisboa Central (score 0.0738), CH Lisboa Norte (score 0.0753) and CH São João (score 0.907).

Conclusion 4: When we relate doctors, nurses and all the operating costs to consultations, there is no cause-effect relationship between the resources available at the EPE Hospitals and the healthcare results.

AED (6x1) Doctors, Nurses, Capacity, Staff Costs, Cost of Goods Sold and Materials Consumed and External Supplies and Services vs Emergency Departments 2015

```
EFFICIENCY SUMMARY:

 firm     te
    1  0.851
    2  0.771
    3  0.289
    4  0.867
    5  0.528
    6  0.823
    7  0.349
    8  0.325
    9  0.376
   10  0.972
   11  1.000
   12  0.326
   13  1.000
   14  0.439
   15  0.602
   16  0.577
   17  1.000
   18  0.416
   19  0.959
   20  1.000
   21  0.530
   22  0.775
   23  0.626
   24  0.432
   25  0.525
   26  1.000
   27  0.350
   28  0.385

mean  0.646
```

In 2015, based on a rationale (6x1), we see that the efficiency between all productive factors and consultations is on average 0.646, which is a reasonable value not far from the efficiency frontier, but less efficient than what we identified for consultations.

As mentioned above, this will be the most relevant efficiency test since it includes all the factors of production that we consider in this study, which have been widely validated as mentioned above and are totally decisive for hospital production, namely doctors, nurses, staffing, staff costs, costs of goods sold and materials consumed and external supplies and services.

It should be noted that the use of "contractors", i.e. outsourced doctors and specialised staff (nurses and technicians), is particularly relevant with regard to the emergency services, i.e. a very significant part of these costs, expressed under the heading of staff costs, are earmarked for the emergency services and are therefore absolutely decisive for the maintenance (as we know it) of care services.

In the context of this analysis, in 2015 the EPE Hospitals that perform efficiently (score 1) are the following:

- Médio Tejo Hospital Centre;
- Póvoa Hospital Centre;
- Barcelos Hospital;
- Figueira da Foz Hospital;
- ULS Litoral Alentejano.

On the other hand, the EPE Hospitals that perform less efficiently remain the following:
- Coimbra Hospital Centre (score 0.289);
- Lisbon Central Hospital Centre (score 0.349);
- Centro Hospitalar Lisboa Norte (score 0.325);
- Centro Hospitalar Lisboa Ocidental (score 0.376);
- Porto Hospital Centre (score 0.326);
- ULS Nordeste (score 0.385).

By analysing the results, we come to a conclusion, which fortunately and not occasionally coincides with reality: these results reflect the colossal asymmetry in the influx of emergency patients, thus reflecting the dichotomy of coast vs interior and big cities vs peripheries. This could suggest that an important source of hospital inefficiency is the strategy (or lack of strategy) of territorial implementation and, in fact, the strategic component is something that is totally co-related with the results that we are trying to show in this work.

The politicisation, and now irrationality, in the discussion of the national health strategy translates into an SNS in "patchwork mode", where it is possible for professionals, supported by a "hospital administration" that tends to be mediocre, to open specialities without an integrated analysis of the available supply and demand, or even an assessment of all the technical and human requirements necessary for the operation.
This issue is clearly visible in the inability to realise and implement a minimally balanced hospital charter, as well as referral networks that function properly and in a simple and swift manner.

AED (6x1) Doctors, Nurses, Capacity, Staff Costs, Cost of Goods Sold and Materials Consumed and External Supplies and Services vs Emergency 2016

```
EFFICIENCY SUMMARY:

 firm     te
    1  0.860
    2  0.774
    3  0.299
    4  0.880
    5  0.547
    6  0.841
    7  0.361
    8  0.351
    9  0.374
   10  1.000
   11  1.000
   12  0.316
   13  1.000
   14  0.453
   15  0.575
   16  0.571
   17  1.000
   18  0.416
   19  0.956
   20  1.000
   21  0.547
   22  0.776
   23  0.627
   24  0.484
   25  0.544
   26  1.000
   27  0.359
   28  0.409

mean  0.654
```

In 2016, based on a rationale (6x1), we can see that the efficiency between all productive factors and consultations is on average 0.654, which is a reasonable value not far from the efficiency frontier, and we can see a slight improvement on 2015.

In the context of this analysis, in 2016 the EPE Hospitals that perform efficiently (score 1) remain the same as in 2015:

- Médio Tejo Hospital Centre;
- Póvoa Hospital Centre;
- Barcelos Hospital;
- Figueira da Foz Hospital;
- ULS Litoral Alentejano;

In 2016, another EPE Hospital joined the Group:

- Médio Ave Hospital Centre;

On the other hand, the EPE hospitals that act less efficiently remain essentially the same as those we saw in 2015.
Inherently, the emergency activity is the most difficult to manage, and in this regard, although the hospital chart in use results in the concentration of many more hospitals near the big cities and on the coast, there is still no homogeneous level of efficiency between these two antagonistic realities.

In 2016, if we consider the EPE Hospitals with the most significant number of doctors and nurses, as well as the operating costs considered in this study, namely staff costs, cost of goods sold and materials consumed, and external supplies and services, we can see that the EPE Hospitals with the most resources are those with the lowest efficiency in terms of emergency services.

Conclusion 4: When we relate doctors, nurses and all the operating costs of emergency services, there is no cause-and-effect relationship between the resources available at the EPE Hospitals and the healthcare results seen.

AED (6x1) Doctors, Nurses, Capacity, Staff Costs, Cost of Goods Sold and Materials Consumed and External Supplies and Services vs Surgeries 2015

```
EFFICIENCY SUMMARY:

 firm     te
    1  0.377
    2  0.402
    3  0.539
    4  0.935
    5  0.918
    6  0.725
    7  0.635
    8  0.446
    9  0.650
   10  0.680
   11  0.917
   12  0.541
   13  1.000
   14  0.938
   15  0.875
   16  0.405
   17  0.905
   18  0.986
   19  0.572
   20  1.000
   21  0.608
   22  0.457
   23  0.726
   24  0.634
   25  0.496
   26  0.553
   27  0.423
   28  0.498

mean  0.673
```

In 2015, based on a rationale (6x1), we see that the efficiency between all productive factors and consultations is on average 0.673, which is a reasonable value not far from the efficiency frontier, but less efficient than what we identified for consultations.

In this regard, it is important to clarify that this work aims to identify efficiency scores in the context of the proposed models, and for this reason these results should not be correlated with the information contained in surgical waiting lists, which is the result of a system that is not optimised and which therefore allows the development of surgical

activity to be carried out based essentially on the arbitrary choice of health professionals and circumstances that severely affect the development of services, such as strikes.

It was not possible to identify or quantify the impact that these sectoral strikes had on surgical production, i.e. how much surgical production was not carried out following the strikes, or to compare the number of strikes in 2015 and 2016, or the prevalence rate of strikes according to the political party or parties that support the government.

The impact of strikes in the health sector is a very important factor to take into account, as it makes clear the formal and informal power of the professional classes (doctors and nurses), as well as how they have evolved over time, as it is now perfectly commonplace to set up *crowdfunding* mechanisms to support the strikers financially.

This situation has put the possible conflict between the right to strike and the right to health, both of which are enshrined in the Constitution of the Republic, at the centre of some political discussion.

In the context of this analysis, in 2015 the EPE Hospitals that perform efficiently (score 1) are the following:

- Póvoa Hospital Centre;
- Figueira da Foz Hospital.

Then in 2015 we have a group of EPE Hospitals that perform well (score > 0.9) in terms of efficiency:

- Douro and Vouga Hospital Centre;
- Gaia - Espinho Hospital Centre;
- Médio Tejo Hospital Centre;
- São João Hospital Centre;
- Barcelos Hospital;
- Évora Hospital.

The EPE Hospitals that performed less well were the following:

- Algarve Hospital Centre;
- Barreiro Hospital Centre;
- Lisbon North Hospital Centre;
- Traz os Montes Hospital Centre;
- Santarém Hospital;
- Guarda Local Health Unit;
- Matosinhos Local Health Unit;
- Local Health Unit of the Northeast.

AED (6x1) Doctors, Nurses, Capacity, Staff Costs, Cost of Goods Sold and Materials Consumed and External Supplies and Services vs Surgeries 2016

```
EFFICIENCY SUMMARY:

 firm     te
    1  0.391
    2  0.413
    3  0.516
    4  0.881
    5  0.934
    6  0.706
    7  0.634
    8  0.426
    9  0.604
   10  0.703
   11  1.000
   12  0.524
   13  1.000
   14  0.902
   15  0.901
   16  0.430
   17  0.862
   18  0.979
   19  0.771
   20  1.000
   21  0.610
   22  0.487
   23  0.778
   24  0.687
   25  0.513
   26  0.703
   27  0.393
   28  0.408

mean  0.684
```

In 2016, based on a rationale (6x1), we can see that the efficiency between all productive factors and consultations is on average 0.684, which is a reasonable value not far from the efficiency frontier, as well as a positive evolution compared to 2015.

In the context of this analysis, in 2016 the EPE Hospitals that perform efficiently (score 1) are the following:

- Póvoa Hospital Centre;
- Figueira da Foz Hospital;
- Médio Tejo Hospital Centre;

Then in 2015 we have a group of EPE Hospitals that perform well (score > 0.9) in terms of efficiency:

- Gaia - Espinho Hospital Centre;
- São João Hospital Centre;
- Tondela - Viseu Hospital Centre;
- Évora Hospital.

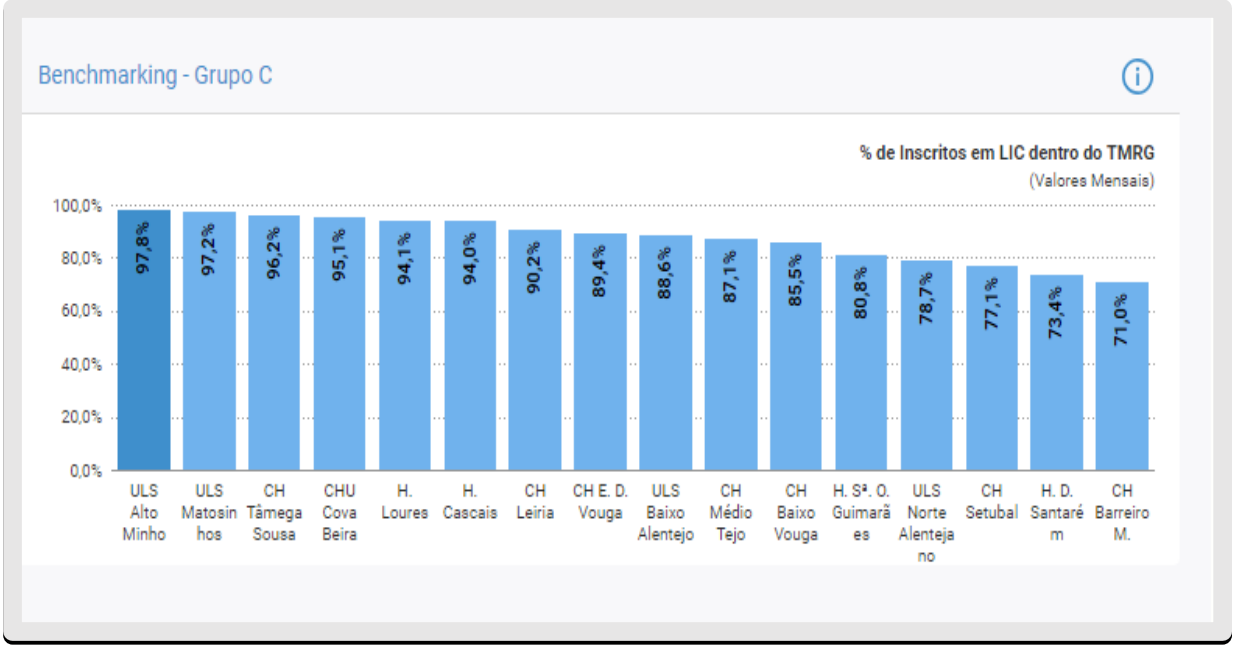
The EPE Hospitals that performed less well in 2016 were the following:

- Algarve Hospital Centre;
- Barreiro Hospital Centre;
- Lisbon North Hospital Centre;
- Traz os Montes Hospital Centre;
- Santarém Hospital;
- Matosinhos Local Health Unit.

If we compare these results with the ACSS benchmarking at 31/12/2016, it is interesting to see some areas of similarity between the results obtained and a KPI identified by the ACSS as relevant, namely the % of patients on the surgical waiting list (LIC) within the maximum guaranteed response times (TMRG).

Basically, the higher the % of patients enrolled, the greater the institution's capacity to carry out surgery, which can be a good indication of greater efficiency in the organisation's operational management.

Figure 20: ACSS Benchmarking - Group C



Source: ACSS

In this case, with regard to the Barreiro Hospital Centre and Santarém Hospital in Group C, there is a clear relationship between the lower performance in terms of efficiency and the low % of people enrolled in LICs during the TMRG. On the other hand, there is no such relationship between the Matosinhos Local Health Unit and the high % of people enrolled in LICs during the TMRG.

This issue may be related to the hospital management model, which we will analyse in detail in the research hypotheses below.

In 2016, if we consider the EPE Hospitals with the most significant number of doctors and nurses, as well as the operating costs considered in this study, namely staff costs, cost of goods sold and materials consumed, and external supplies and services, we can

see that the EPE Hospitals with the most resources are not the ones with the most efficient emergency services.

Conclusion 5: When we relate doctors, nurses and all the operating costs to consultations, there is no cause-effect relationship between the resources available at the EPE Hospitals and the healthcare results seen.

FRONTIER (2x1) Doctors, Nurses vs Consultations 2015

firm	eff.-est.
1	0.30242700E+00
2	0.56902249E+00
3	0.78600335E-01
4	0.67796448E+00
5	0.84023983E+00
6	0.63157009E+00
7	0.99946181E+00
8	0.53319961E+00
9	0.81173956E+00
10	0.53283565E+00
11	0.97463786E+00
12	0.94126145E+00
13	0.35350582E+00
14	0.97968009E+00
15	0.35252950E+00
16	0.37596255E+00
17	0.36904456E+00
18	0.58222730E+00
19	0.68419678E+00
20	0.41661873E+00
21	0.67262379E+00
22	0.27856526E+00
23	0.34121161E+00
24	0.19789095E+00
25	0.26607006E+00
26	0.36029365E+00
27	0.35888666E+00
28	0.24865280E+00

mean efficiency = 0.52610430E+00

Now using the FRONTIER program, which involves the Stochastic Frontier Analysis (SFA) methodology through the estimation of transcendental logarithmic functions (translog), operating costs were analysed as a function of output variables.

In 2015, based on a rationale (2x1), we can see that the efficiency between doctors, nurses and consultations is on average 0.526, which is an average value between inefficiency and efficiency.

In this context, the EPE Hospitals with the best performance are the following:

- Lisbon Central Hospital Centre;
- Médio Tejo Hospital Centre;
- Porto Hospital Centre;
- São João Hospital Centre;

On the other hand, the EPE hospitals with the worst performance are the following:

- Santarém Hospital;
- ULS Castelo Branco;
- ULS Guarda;
- ULS Northeast.

FRONTIER (2x1) Doctors, Nurses vs Consultations 2016

firm	eff.-est.
1	0.25471317E+00
2	0.46122495E+00
3	0.81997824E-01
4	0.73433454E+00
5	0.73923110E+00
6	0.64849852E+00
7	0.99824032E+00
8	0.49982205E+00
9	0.67440117E+00
10	0.36352246E+00
11	0.92385585E+00
12	0.91517507E+00
13	0.21616019E+00
14	0.99347694E+00
15	0.35314611E+00
16	0.39298877E+00
17	0.16918246E+00
18	0.55090132E+00
19	0.79637180E+00
20	0.45942972E+00
21	0.73661781E+00
22	0.34708605E+00
23	0.33406184E+00
24	0.24621394E+00
25	0.31870154E+00
26	0.38369955E+00
27	0.36953127E+00
28	0.26686898E+00

mean efficiency = 0.50819483E+00

In 2016, based on the same rationale (2x1), we can see that the efficiency between doctors, nurses and consultations is on average 0.508, which is slightly worse than the previous year.

In this context, the EPE Hospitals with the best performance are the following:

- Médio Tejo Hospital Centre;
- Porto Hospital Centre;
- São João Hospital Centre.

On the other hand, the EPE hospitals with the worst performance are the following:

- Algarve Hospital Centre;
- ULS Castelo Branco;
- ULS Northeast;

FRONTIER (2x1) Personnel Costs, CMVMC vs Consultations 2015

firm	eff.-est.
1	0.30229454E+00
2	0.59265143E+00
3	0.77973545E-01
4	0.72085245E+00
5	0.84203797E+00
6	0.66593431E+00
7	0.54822874E+00
8	0.97645886E+00
9	0.81017382E+00
10	0.55067931E+00
11	0.56097756E+00
12	0.95598698E+00
13	0.37878392E+00
14	0.99971056E+00
15	0.66907144E+00
16	0.38556599E+00
17	0.39744442E+00
18	0.60804695E+00
19	0.72826427E+00
20	0.45514001E+00
21	0.38316745E+00
22	0.30007326E+00
23	0.34594885E+00
24	0.20474722E+00
25	0.28506670E+00
26	0.38692379E+00
27	0.36604238E+00
28	0.26428789E+00

mean efficiency = 0.52723338E+00

In 2015, based on a rationale (2x1), we can see that the efficiency between staff costs and costs of goods sold and materials consumed (cmvmc) and consultations is on average 0.527, i.e. an average value between inefficiency and efficiency.

In this context, the EPE Hospitals with the best performance are the following:

- Lisbon North Hospital Centre;
- São João Hospital Centre.

On the other hand, the EPE hospitals with the worst performance are the following:

- ULS Castelo Branco;

- ULS Guarda;

- ULS Northeast.

In this regard, in 2015, there was a prevalence of results that were more achieved by Hospital Centres in national terms and less achieved by Local Health Units, two of which were in the interior of the country and one relatively close to a large city.

The difference in scoring is very significant between the best and worst performers in this analysis context.

FRONTIER (2x1) Personnel Costs, CMVMC vs Consultations 2016

firm	eff.-est.
1	0.25768918E+00
2	0.56330501E+00
3	0.68189045E-01
4	0.88990482E+00
5	0.74704887E+00
6	0.78752131E+00
7	0.43987004E+00
8	0.95152982E+00
9	0.68258132E+00
10	0.43835152E+00
11	0.59592510E+00
12	0.92155390E+00
13	0.59998700E+00
14	0.99902513E+00
15	0.35532333E+00
16	0.39470467E+00
17	0.47152309E+00
18	0.67083071E+00
19	0.96377543E+00
20	0.67283839E+00
21	0.39117726E+00
22	0.41885606E+00
23	0.33643415E+00
24	0.29883857E+00
25	0.38515194E+00
26	0.24699995E+00
27	0.37152733E+00
28	0.32347182E+00

mean efficiency = 0.54442624E+00

In 2016, based on a rationale (2x1), we can see that the efficiency between staff costs and costs of goods sold and materials consumed (cmvmc) and consultations is on average 0.544, which is an average value between inefficiency and efficiency and slightly better than in 2015.

In this context, the EPE Hospitals with the best performance are the following:

- Lisbon North Hospital Centre;
- Porto Hospital Centre;
- Fernando Fonseca Hospital.

On the other hand, the EPE hospitals with the worst performance are the following:

- Algarve Hospital Centre;
- ULS Castelo Branco;
- ULS Litoral Alentejano.

In this case, in 2016, there was no prevalence of results being achieved more by Hospital Centres in national terms and results being achieved less by Local Health Units, two of which were in the interior of the country and one relatively close to a large city.

When we analyse the results obtained through FRONTIER, not only when we relate doctors and nurses, but also when we relate personnel costs and costs of goods sold and materials consumed to consultations, we see that there is not always a directly proportional relationship between available resources and care results.

Conclusion 6: When we relate doctors and nurses to consultations, there isn't always a cause-and-effect relationship between the resources available at EPE Hospitals and the care results that are seen.

Conclusion 7: When we relate personnel costs and costs of goods sold and materials consumed to consultations, there is not always a cause-and-effect relationship between the resources available at the EPE Hospitals and the healthcare results.

FRONTIER (2x1) Doctors, Nurses vs ER 2015

```
    firm             eff.-est.

      1           0.94190651E+00
      2           0.92640742E+00
      3           0.93567814E+00
      4           0.94266188E+00
      5           0.93771409E+00
      6           0.94336569E+00
      7           0.94003589E+00
      8           0.93365533E+00
      9           0.92627409E+00
     10           0.93108135E+00
     11           0.93741076E+00
     12           0.92547793E+00
     13           0.93321609E+00
     14           0.94003138E+00
     15           0.93821287E+00
     16           0.93804890E+00
     17           0.93192817E+00
     18           0.92716611E+00
     19           0.94481262E+00
     20           0.93311745E+00
     21           0.93223992E+00
     22           0.93106859E+00
     23           0.91982962E+00
     24           0.92619193E+00
     25           0.92962801E+00
     26           0.93470342E+00
     27           0.92090223E+00
     28           0.92746104E+00


mean efficiency =   0.93322241E+00
```

In 2015, based on a rationale (2x1), we can see that the efficiency between doctors and nurses and emergency services is on average 0.933, i.e. it has an average value very close to efficiency with all scores above 0.9.

FRONTIER (2x1) Doctors, Nurses vs Emergency 2016

```
    firm             eff.-est.

      1           0.94388084E+00
      2           0.93465936E+00
      3           0.93684585E+00
      4           0.94307932E+00
      5           0.93769818E+00
      6           0.94413955E+00
      7           0.94111660E+00
      8           0.93429508E+00
      9           0.92915539E+00
     10           0.93346798E+00
     11           0.94076933E+00
     12           0.92810492E+00
     13           0.92736579E+00
     14           0.94123919E+00
     15           0.93778510E+00
     16           0.93789414E+00
     17           0.92655275E+00
     18           0.92754786E+00
     19           0.94644914E+00
     20           0.93391937E+00
     21           0.94228171E+00
     22           0.93366567E+00
     23           0.93698464E+00
     24           0.92613050E+00
     25           0.93129423E+00
     26           0.93634709E+00
     27           0.92102718E+00
     28           0.92790924E+00


mean efficiency =   0.93505736E+00
```

In 2016, based on a rationale (2x1), we can see that the efficiency between doctors and nurses and emergency services is on average 0.935, i.e. it consistently shows an average value very close to efficiency with all scores above 0.9.

This situation reflects our health system's commitment to a concept focused on emergencies, with the EPE Hospital as the centre of the hospital universe.

In this context, if we analyse 2015 and 2016, the EPE Hospitals with the best performance are the following:

2015:

- Algarve Hospital Centre;
- Leiria Hospital Centre;
- Lisbon Central Hospital Centre;
- São João Hospital Centre;
- Fernando da Fonseca Hospital.

2016:

- Algarve Hospital Centre (consistent with 2015);
- Centro Hospitalar Lisboa Central (consistent with 2015);
- Douro and Vouga Hospital Centre;
- Leiria Hospital Centre;
- Médio Tejo Hospital Centre;
- São João Hospital Centre;
- Fernando da Fonseca Hospital;
- Garcia de Orta Hospital.

FRONTIER (2x1) Personnel Costs, CMVMC vs ER 2015

firm	eff.-est.
1	0.94117764E+00
2	0.92365293E+00
3	0.93435822E+00
4	0.94000188E+00
5	0.93481768E+00
6	0.94108962E+00
7	0.93316991E+00
8	0.93669227E+00
9	0.92659521E+00
10	0.93067536E+00
11	0.93196461E+00
12	0.92543233E+00
13	0.93102910E+00
14	0.93836829E+00
15	0.94054546E+00
16	0.93533595E+00
17	0.92905591E+00
18	0.92481116E+00
19	0.94329784E+00
20	0.93087879E+00
21	0.92648869E+00
22	0.93065657E+00
23	0.91697789E+00
24	0.92332272E+00
25	0.92852112E+00
26	0.93327916E+00
27	0.91860988E+00
28	0.92525954E+00

mean efficiency = 0.93128806E+00

In 2015, based on a rationale (2x1), we can see that the efficiency between staff costs and cmvmc and urgencies is on average 0.931, i.e. it has an average value very close to efficiency with all scores above 0.9. These efficiency figures would be predictable given the results seen when we analysed the medical and nursing inputs, because the efficiency levels above are too high to see results that are manifestly different from the current assumptions.

FRONTIER (2x1) Personnel Costs, CMVMC vs Emergency 2016

firm	eff.-est.
1	0.95020984E+00
2	0.94228159E+00
3	0.94190118E+00
4	0.94913111E+00
5	0.94278734E+00
6	0.95038085E+00
7	0.94032219E+00
8	0.94557457E+00
9	0.93592514E+00
10	0.94088485E+00
11	0.94288535E+00
12	0.93465624E+00
13	0.94113755E+00
14	0.94708128E+00
15	0.94289406E+00
16	0.94302785E+00
17	0.94028175E+00
18	0.93378808E+00
19	0.95306514E+00
20	0.94124982E+00
21	0.94178161E+00
22	0.94111738E+00
23	0.94190882E+00
24	0.93205283E+00
25	0.93830855E+00
26	0.93699867E+00
27	0.92592056E+00
28	0.93422838E+00

mean efficiency = 0.94113509E+00

In 2016, based on a rationale (2x1), we can see that the efficiency between staff costs and cmvmc and urgencies is on average 0.941, i.e. it consistently shows an average value very close to efficiency with all scores above 0.9.

In this context, if we analyse 2015 and 2016, the EPE Hospitals with the best performance are the following:

2015:
- Algarve Hospital Centre;
- Leiria Hospital Centre;
- Tondela Viseu Hospital Centre;
- Fernando da Fonseca Hospital.

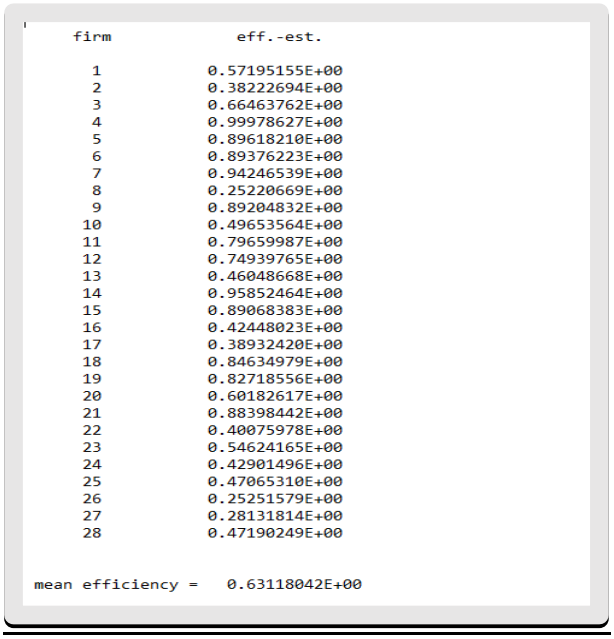
2016:
- Algarve Hospital Centre (consistent with 2015);
- Leiria Hospital Centre (consistent with 2015);
- Fernando da Fonseca Hospital (consistent with 2015);

When we analyse the results obtained through FRONTIER in relation to emergency services, we see that there is not always a directly proportional relationship between available resources and healthcare results.

Conclusion 8: When we relate doctors and nurses to emergency services, there isn't always a cause-and-effect relationship between the resources available at the EPE Hospitals and the results of the care provided.

Conclusion 9: When we relate personnel costs and costs of goods sold and materials consumed to emergencies, there isn't always a cause-effect relationship between the resources available at the EPE Hospitals and the healthcare results that are seen.

FRONTIER (2x1) Doctors, Nurses vs Surgeries 2015



firm	eff.-est.
1	0.57195155E+00
2	0.38222694E+00
3	0.66463762E+00
4	0.99978627E+00
5	0.89618210E+00
6	0.89376223E+00
7	0.94246539E+00
8	0.25220669E+00
9	0.89204832E+00
10	0.49653564E+00
11	0.79659987E+00
12	0.74939765E+00
13	0.46048668E+00
14	0.95852464E+00
15	0.89068383E+00
16	0.42448023E+00
17	0.38932420E+00
18	0.84634979E+00
19	0.82718556E+00
20	0.60182617E+00
21	0.88398442E+00
22	0.40075978E+00
23	0.54624165E+00
24	0.42901496E+00
25	0.47065310E+00
26	0.25251579E+00
27	0.28131814E+00
28	0.47190249E+00

mean efficiency = 0.63118042E+00

In 2015, based on a rationale (2x1), we can see that the efficiency between doctors, nurses and surgeries is an average of 0.631.

In this context, if we analyse 2015, the EPE Hospitals with the best performance are the following:

- Entre Douro e Vouga Hospital Centre;
- Lisbon Central Hospital Centre;
- São João Hospital Centre;
- Évora Hospital.

On the other hand, the EPE hospitals with the worst performance are the following:

- Lisbon North Hospital Centre;
- Litoral Alentejano Local Health Unit;
- Matosinhos Local Health Unit.

FRONTIER (2x1) Doctors, Nurses vs Surgeries 2016

firm	eff.-est.
1	0.50344789E+00
2	0.34027473E+00
3	0.65288491E+00
4	0.84137143E+00
5	0.91460868E+00
6	0.79532978E+00
7	0.94619671E+00
8	0.49059152E+00
9	0.90771646E+00
10	0.38980746E+00
11	0.87631687E+00
12	0.63816145E+00
13	0.27495467E+00
14	0.95665451E+00
15	0.91328074E+00
16	0.43822497E+00
17	0.25125947E+00
18	0.75922270E+00
19	0.99975358E+00
20	0.52198321E+00
21	0.82993438E+00
22	0.36272300E+00
23	0.52186227E+00
24	0.36180992E+00
25	0.49267550E+00
26	0.34711280E+00
27	0.22639135E+00
28	0.33347743E+00

mean efficiency = 0.60314387E+00

In 2016, based on a rationale (2x1), we can see that the efficiency between doctors, nurses and surgeries is on average 0.603, which is average and slightly lower than in 2015.

In this context, if we analyse 2016, the EPE Hospitals with the best performance are the following:

- Gaia Espinho Hospital Centre;
- Lisbon West Hospital Centre;
- São João Hospital Centre;
- Tondela Viseu Hospital Centre;
- Fernando da Fonseca Hospital.

In this context, if we analyse 2016, the EPE Hospitals with the worst performance are the following:

- Póvoa Hospital Centre;
- ULS Matosinhos.

FRONTIER (2x1) Personnel Costs, CMVMC vs Surgeries 2015

firm	eff.-est.
1	0.72407048E+00
2	0.59543228E+00
3	0.70551531E+00
4	0.89294196E+00
5	0.81245148E+00
6	0.86908506E+00
7	0.69671813E+00
8	0.46637455E+00
9	0.81064905E+00
10	0.74644582E+00
11	0.66038833E+00
12	0.84139888E+00
13	0.66051972E+00
14	0.83655986E+00
15	0.89072822E+00
16	0.54954594E+00
17	0.56080014E+00
18	0.85467305E+00
19	0.84797870E+00
20	0.79999520E+00
21	0.76078981E+00
22	0.62373208E+00
23	0.69835092E+00
24	0.66449767E+00
25	0.71783956E+00
26	0.35455173E+00
27	0.46915598E+00
28	0.71930217E+00

mean efficiency = 0.70823186E+00

In 2015, based on a rationale (2x1), we can see that the efficiency between staff costs, CVMC and surgeries is on average 0.708, i.e. an average/high value in terms of efficiency. In this context, if we analyse 2015, the EPE Hospitals with the best performance are the following:

- Entre Douro e Vouga Hospital Centre;
- Leiria Hospital Centre;
- Tondela Viseu Hospital Centre;
- Évora Hospital.

In this context, if we analyse 2015, the EPE Hospitals with the worst performance are the following:

- Lisbon North Hospital Centre;
- ULS Litoral Alentejano;
- ULS Matosinhos.

FRONTIER (2x1) Personnel Costs, CMVMC vs Surgeries 2016

firm	eff.-est.
1	0.73194770E+00
2	0.67073997E+00
3	0.73493802E+00
4	0.87225305E+00
5	0.83675066E+00
6	0.86174799E+00
7	0.73106450E+00
8	0.84551608E+00
9	0.83486904E+00
10	0.73063103E+00
11	0.78719361E+00
12	0.81520807E+00
13	0.73263743E+00
14	0.84737619E+00
15	0.83639136E+00
16	0.67089640E+00
17	0.69380982E+00
18	0.85213413E+00
19	0.89796722E+00
20	0.82226825E+00
21	0.77763365E+00
22	0.69971421E+00
23	0.74645742E+00
24	0.69859539E+00
25	0.71155673E+00
26	0.50368523E+00
27	0.49496999E+00
28	0.66136603E+00

mean efficiency = 0.75358283E+00

In 2016, based on a rationale (2x1), we can see that the efficiency between staff costs, cmvmc and surgeries is on average 0.753, i.e. an average/high value in terms of efficiency, as well as a positive evolution compared to 2015.

In this context, if we analyse 2016, the EPE Hospitals with the best performance are the following:

- Entre Douro e Vouga Hospital Centre;
- Leiria Hospital Centre;
- Évora Hospital;
- Fernando da Fonseca Hospital.

In this context, if we analyse 2016, the EPE Hospitals with the worst performance are the following:

- ULS Litoral Alentejano;
- ULS Matosinhos.

When we analyse the results obtained through FRONTIER in relation to emergency services, once again we see that there is not always a directly proportional relationship between available resources and healthcare results.

Conclusion 10: When we relate doctors and nurses to surgeries, there isn't always a cause-and-effect relationship between the resources available at the EPE Hospitals and the healthcare results.

Conclusion 11: When we relate personnel costs and costs of goods sold and materials consumed to surgeries, there is not always a cause-and-effect relationship between the resources available at the EPE Hospitals and the healthcare results seen.

8.2. Research Hypothesis II

8.2.1 Objective

As mentioned above, in this hypothesis we will try to see if the technical efficiency frontier shows similarities between the various hospital models, namely local health units, hospital centres and hospitals.

With this hypothesis, we can try to determine whether the performance of the various hospital models is similar to each other, or whether the values are independent of the underlying hospital model,

Then, on the basis of the relational patterns verified, we will try to validate whether or not there is a rational relationship between the factors.

8.2.2 Data and variables

With regard to the data and variables, following on from the literature review above, we considered the number of doctors, number of nurses, capacity, staff costs, costs of goods sold and materials consumed, supplies and external services as input variables, and the number of outpatient consultations, number of emergency episodes and number of surgeries as output variables.

As we can see in Figure 18, these variables have a very acceptable level of correlation, and in this sense they represent what is essential in a hospital's care performance, because without any of the inputs it is not possible to carry out care activity.

On the other hand, since it is a common feature of all hospitals, all the above inputs will be utilised differently, not only depending on the management model underlying hospital management, but also on their specific characteristics.

In this context, we analysed the aforementioned inputs and outputs in the context of DEA and SFA estimations, using the DEAP and FRONTIER models for the 28 hospitals in 2015 and 2016.

8.2.3 Application of the model

As in point 8.3 above, various estimations were carried out using the data envelopment analysis (DEA) efficiency frontier methodological approach with the aim of calculating the efficient production frontier and analysing the behaviour of the twenty-eight hospitals considered in the sample from this frontier.

This efficiency frontier has been estimated using very different methods and techniques over the last 40 years, with data envelopment analysis (DEA) and stochastic frontiers (SFA) being the two main methods in use.

These methods involve mathematical programming and econometric methods, and in this work they were estimated using the DEAP and FRONTIER software mentioned above. This was also a challenge within the scope of this research work: to know, use and interpret the results of the outputs generated by these two information systems.

The "modern" efficiency calculations had Farrel (1957) as a precursor who developed the work of Debreu (1951) and Koopmans (1951) to define a simple measure of efficiency that considered multiple inputs.

Farrel distinguished between technical efficiency, as the possibility of obtaining a maximum of outputs for a quantity of inputs, and allocative efficiency, which reflects the possibility of a company optimising the use of inputs, taking into account the respective prices.

These two measures combined therefore result in total economic efficiency.
Next, we need to distinguish between input-orientated efficiency measures and output-orientated efficiency measures.

Input-orientated efficiency measures aim to identify how many units of inputs can be proportionally reduced without changing the quantities of outputs produced.

Output-orientated efficiency measures aim to identify how many additional units of output can be proportionally produced without changing the quantities of inputs produced.

Data envelopment analysis (DEA) is therefore a non-parametric approach to mathematical programming aimed at estimating the optimal production frontier, which has been thoroughly tested and therefore has the conceptual stability needed to be considered as a proxy in operational risk management models in healthcare units with a management model as described above.

The revision and validation of these models were greatly developed in the 1990s by Seiford and Thall (1990), Lovell (1993), Ali and Seiford (1993), Lovell (1994), Charnes et al (1995) and Seiford.

In Portugal, one of the authors who uses this approach is Pedro Pitta Barros, one of the Portuguese specialists in health economics. In this work, the novelty we are trying to introduce will be to use this methodology as a *proxy* for a KPI in the context of an operational risk management model.

The reasonableness of this approach is verified by the fact that the government is studying the possibility of introducing efficiency criteria to measure EPE Hospitals in the near future.

8.2.4 Analysing results

Following on from the estimations, and in accordance with point 8.4 above, we used a programme developed by Tim Coelli (PhD), a professor at the Australian University of New England, namely the DEAP programme which involves the data envelopment analysis (DEA) methodology based on Malmquist indices.

We also used the FRONTIER program, which involves the Stochastic Frontier Analysis (SFA) methodology through the estimation of transcendental logarithmic functions (translog) where operating costs were analysed as a function of output variables.

In order to test this hypothesis, we will analyse all the results obtained in the above tests to see whether or not there is a consistency of results between the three organisational models used in EPE Hospitals, i.e. Hospital Centres, Hospitals and Local Health Units.

Overall, we can see that for all 24 tests carried out, the most efficient organisational model is the EPE Hospital with an average efficiency of 0.726, followed by the Hospital Centre with an average efficiency of 0.720 and finally, the least efficient organisational model is the local health units.

If we take a closer look at all the dimensions of analysis considered in this work, we can see the detail of these global figures.

AED (1x1) Doctors vs Consultations 2015

AVG CH	0,513
AVG H	0,577
AVG ULS	0,336

AED (1x1) Doctors vs Consultations 2016

AVG CH	0,481
AVG H	0,533
AVG ULS	0,341

AED (1x1) Nurses vs Consultations 2015

AVG CH	0,639
AVG H	0,668
AVG ULS	0,421

AED (1x1) Nurses vs Consultations 2016

AVG CH	0,660
AVG H	0,698
AVG ULS	0,459

AED (2x2) Doctors and Nurses vs Consultations and Surgeries 2015

AVG CH	0,736
AVG H	0,772
AVG ULS	0,475

AED (2x2) Doctors and Nurses vs Consultations and Surgeries 2016

AVG CH	0,757

AVG H	0,793
AVG ULS	0,519

AED (6x1) Doctors, Nurses, Capacity, Staff Costs, Cost of Goods Sold and Materials Consumed and External Supplies and Services vs Consultations 2015

AVG CH	0,792
AVG H	0,812
AVG ULS	0,665

AED (6x1) Doctors, Nurses, Capacity, Staff Costs, Cost of Goods Sold and Materials Consumed and External Supplies and Services vs Consultations 2016

AVG CH	0,807
AVG H	0,836
AVG ULS	0,710

AED (6x1) Doctors, Nurses, Capacity, Staff Costs, Cost of Goods Sold and Materials Consumed and External Supplies and Services vs Emergency Departments 2015

AVG CH	0,631
AVG H	0,777
AVG ULS	0,553

AED (6x1) Doctors, Nurses, Capacity, Staff Costs, Cost of Goods Sold and Materials Consumed and External Supplies and Services vs Emergency 2016

AVG CH	0,638
AVG H	0,783
AVG ULS	0,571

AED (6x1) Doctors, Nurses, Capacity, Staff Costs, Cost of Goods Sold and Materials Consumed and External Supplies and Services vs Surgeries 2015

AVG CH	0,686
AVG H	0,755
AVG ULS	0,555

AED (6x1) Doctors, Nurses, Capacity, Staff Costs, Cost of Goods Sold and Materials Consumed and External Supplies and Services vs Surgeries 2016

AVG CH	0,685
AVG H	0,785
AVG ULS	0,580

FRONTIER (2x1) Doctors, Nurses vs Consultations 2015

AVG CH	0,666
AVG H	0,500

AVG ULS	0,295

FRONTIER (2x1) Doctors, Nurses vs Consultations 2016

AVG CH	0,624
AVG H	0,510
AVG ULS	0,319

FRONTIER (2x1) Personnel Costs, CMVMC vs Consultations 2015

AVG CH	0,671
AVG H	0,479
AVG ULS	0,308

FRONTIER (2x1) Personnel Costs, CMVMC vs Consultations 2016

AVG CH	0,644
AVG H	0,598
AVG ULS	0,327

FRONTIER (2x1) Doctors, Nurses vs ER 2015

AVG CH	0,935
AVG H	0,933
AVG ULS	0,926

FRONTIER (2x1) Doctors, Nurses vs Emergency 2016

AVG CH	0,937
AVG H	0,935
AVG ULS	0,930

FRONTIER (2x1) Personnel Costs, CMVMC vs ER 2015

AVG CH	0,934
AVG H	0,930
AVG ULS	0,924

FRONTIER (2x1) Personnel Costs, CMVMC vs Emergency 2016

AVG CH	0,943
AVG H	0,942
AVG ULS	0,934

FRONTIER (2x1) Doctors, Nurses vs Surgeries 2015

AVG CH	0,704
AVG H	0,658

AVG ULS	0,408

FRONTIER (2x1) Doctors, Nurses vs Surgeries 2016

AVG CH	0,680
AVG H	0,620
AVG ULS	0,380

FRONTIER (2x1) Personnel Costs, CMVMC vs Surgeries 2015

AVG CH	0,734
AVG H	0,741
AVG ULS	0,604

FRONTIER (2x1) Personnel Costs, CMVMC vs Surgeries 2016

AVG CH	0,783
AVG H	0,790
AVG ULS	0,636

The results show that local health units are less efficient than hospital centres and hospitals in all dimensions of analysis.

On the other hand, we found that in 42% of the analysis dimensions considered in this study, the average efficiency of hospital centres was higher than the average efficiency of hospitals, while in 58% of the analysis dimensions, the results of hospitals were higher than those of hospital centres. Given these results, we can conclude that the performance of hospitals and hospital centres is similar to each other, but that the performance of local health units is not similar to the others.

We can therefore conclude that the organisational model is not random in terms of the levels of efficiency found in the EPE Hospitals.

Conclusion 12: In view of the results obtained, we can conclude that the organisational model underlying the EPE hospitals is not random in terms of the levels of efficiency found in the EPE hospitals, i.e. there is a correlation between the organisational models and the results obtained in terms of efficiency.

It is important to note that this conclusion does not imply that the organisational models hospital centres and hospitals are preferable to local health units, because although they show better results in terms of efficiency, they are not affected by the (in)efficiency of ACES, entities with responsibility for managing health centres, or primary health care whenever the organisational model is not the local health unit.

For this reason, we can also conclude that it only makes sense to compare hospitals and hospital centres in terms of efficiency, as the efficiency or inefficiency seen in the ACES that articulate with hospitals and hospital centres cannot be considered in terms of overall results.

Conclusion 13: In view of the results obtained, we can conclude that the organisational model underlying EPE hospitals not only presents robust conditions for comparability between hospitals, hospital centres and local health units.

8.3 Research Hypothesis III

8.3.1 Objective

As mentioned above, in this hypothesis we will try to see if the technical efficiency frontier shows similarities between the various hospital models, namely according to the financing group.

With this hypothesis, we can try to determine whether the performance of the various hospital models is similar to each other, or whether the values are independent of the underlying hospital model,

Then, based on the relational patterns verified, we will try to validate the existence or not of a rational relationship between the factors.

8.3.2 Data and variables

As in points 8.2 and 9.2 above, with regard to data and variables, following the literature review above, we considered the number of doctors, number of nurses, capacity, staff costs, costs of goods sold and materials consumed, supplies and external services as input variables, and the number of outpatient consultations, number of emergency episodes and number of surgeries as output variables.

As we can see in Figure 18, these variables have a very acceptable level of correlation, and in this sense they represent what is essential in a hospital's care performance, because without any of the inputs it is not possible to carry out care activity.

On the other hand, since it is a common feature of all hospitals, all the above inputs will be used differently, not only depending on the management model underlying hospital management, but also on specific characteristics.
In this context, we analysed the aforementioned inputs and outputs in the context of DEA and SFA estimations, using the DEAP and FRONTIER models for the 28 hospitals in 2015 and 2016.

8.3.1 Application of the model

As in points 8.3 and 9.3 above, various estimations were carried out using the methodological approach of the data envelopment analysis (DEA) efficiency frontier in order to calculate the efficient production frontier and from this frontier analyse the behaviour of the twenty-eight hospitals considered in the sample.

These efficiency frontiers have been estimated using very different methods and techniques over the last 40 years, with data envelopment analysis (DEA) and stochastic frontiers (SFA) being the two main methods in use.

These methods involve mathematical programming and econometric methods, and in this work they were estimated using the DEAP and FRONTIER software mentioned above. This was also a challenge within the scope of this research work: to know, use and interpret the results of the outputs generated by these two information systems.

The "modern" efficiency calculations had Farrel (1957) as a precursor who developed the work of Debreu (1951) and Koopmans (1951) to define a simple measure of efficiency that considered multiple inputs.

Farrel distinguished between technical efficiency, as the possibility of obtaining a maximum of outputs for a quantity of inputs, and allocative efficiency, which reflects the possibility of a company optimising the use of inputs, taking into account the respective prices.

These two measures combined therefore result in total economic efficiency.
Next, we need to distinguish between input-orientated efficiency measures and output-orientated efficiency measures.

Input-orientated efficiency measures aim to identify how many units of inputs can be proportionally reduced without changing the quantities of outputs produced.

Output-orientated efficiency measures aim to identify how many additional units of output can be proportionally produced without changing the quantities of inputs produced.

Data envelopment analysis (DEA) is therefore a non-parametric approach to mathematical programming aimed at estimating the optimal production frontier, which has been well tested and therefore has the conceptual stability required to be considered as a proxy in operational risk management models in healthcare units with a management model as described above.

The revision and validation of these models were greatly developed in the 1990s by Seiford and Thall (1990), Lovell (1993), Ali and Seiford (1993), Lovell (1994), Charnes et al (1995) and Seiford.

In Portugal, one of the authors who uses this approach is Pedro Pitta Barros, one of the Portuguese specialists in health economics. In this work, the novelty we are trying to introduce will be to use this methodology as a *proxy* for a KPI in the context of an operational risk management model.

The reasonableness of this approach is verified by the fact that the government is studying the possibility of introducing efficiency criteria to measure EPE Hospitals in the near future.

8.3.4 Analysing Results

Following the estimations, and in accordance with points 8.4 and 9.4 above, we used a programme developed by Tim Coelli (PhD), a professor at the Australian University of New England, namely the DEAP programme, which involves the data envelopment analysis (DEA) methodology based on Malmquist indices.

We also used the FRONTIER program, which involves the Stochastic Frontier Analysis (SFA) methodology through the estimation of transcendental logarithmic functions (translog) where operating costs were analysed as a function of output variables.

In order to test this hypothesis, we will analyse all the results obtained in the above tests, whether or not there is a consistency of results between the various funding groups used to negotiate the annual budgets of the EPE Hospitals, i.e. Hospital Centres, Hospitals and Local Health Units.

In the sample considered in this study, we considered 8 EPE Hospitals (29%) from funding group B, 7 EPE Hospitals (25%) from funding group C, 7 EPE Hospitals (25%) from funding group D and 6 EPE Hospitals (21%) from funding group E.

From this sample we can categorise by funding group as follows:

- In funding group B, we have two hospital centres, two hospitals and four local health units;

- In funding group C, we have three hospital centres, one hospital and two local health units;

- In funding group D, we have four hospital centres, three hospitals and no local health units;

- In funding group E, we have six hospital centres, no hospitals and no local health units.

Overall, the average efficiency of Group B hospitals is 0.635, of Group C hospitals 0.703, of Group D hospitals 0.709 and of Group E hospitals 0.700.
On the other hand, we can see that the standard deviation of the average efficiency of Group B hospitals is 0.150, of Group C hospitals 0.171, of Group D hospitals 0.138 and of Group E hospitals 0.159.

It can thus be seen that the most homogeneous financing group from the point of view of efficiency is group D, made up of hospitals and hospital centres, i.e. although group E is made up entirely of hospital centres, this does not imply that it has a more

homogeneous performance than a group with hospitals and hospital centres. We can therefore conclude that the funding group is not a determining factor in terms of efficiency.

Conclusion 14: In view of the results obtained, we can conclude that the financing group associated with the organisational structure underlying EPE hospitals is not a determining factor in terms of efficiency.

AED (1x1) Doctors vs Consultations 2015

AVG Group B	0,436
Standard Deviation	0,177
AVG Group C	0,588
Standard Deviation	0,264
AVG Group D	0,505
Standard Deviation	0,087
AVG Group E	0,422
Standard Deviation	0,209

AED (1x1) Doctors vs Consultations 2016

AVG Group B	0,419
Standard Deviation	0,171
AVG Group C	0,555
Standard Deviation	0,254
AVG Group D	0,469
Standard Deviation	0,092
AVG Group E	0,404
Standard Deviation	0,197

AED (1x1) Nurses vs Consultations 2015

AVG Group B	0,555
Standard Deviation	0,232
AVG Group C	0,619
Standard Deviation	0,178
AVG Group D	0,636
Standard Deviation	0,151
AVG Group E	0,589
Standard Deviation	0,274

AED (1x1) Nurses vs Consultations 2016

AVG Group B	0,595
Standard Deviation	0,233
AVG Group C	0,633
Standard Deviation	0,180
AVG Group D	0,655
Standard Deviation	0,131
AVG Group E	0,619
Standard Deviation	0,294

AED (2x2) Doctors and Nurses vs Consultations and Surgeries 2015

AVG Group B	0,631
Standard Deviation	0,235
AVG Group C	0,721
Standard Deviation	0,196
AVG Group D	0,732
Standard Deviation	0,114
AVG Group E	0,673
Standard Deviation	0,147

AED (2x2) Doctors and Nurses vs Consultations and Surgeries 2016

AVG Group B	0,663
Standard Deviation	0,232
AVG Group C	0,742
Standard Deviation	0,182
AVG Group D	0,751
Standard Deviation	0,097
AVG Group E	0,706
Standard Deviation	0,173

AED (6x1) Doctors, Nurses, Capacity, Staff Costs, Cost of Goods Sold and Materials Consumed and External Supplies and Services vs Consultations 2015

AVG Group B	0,768
Standard Deviation	0,222
AVG Group C	0,844
Standard Deviation	0,131
AVG Group D	0,757
Standard Deviation	0,130
AVG Group E	0,697
Standard Deviation	0,317

AED (6x1) Doctors, Nurses, Capacity, Staff Costs, Cost of Goods Sold and Materials Consumed and External Supplies and Services vs Consultations 2016

AVG Group B	0,799
Standard Deviation	0,211
AVG Group C	0,867
Standard Deviation	0,125
AVG Group D	0,782
Standard Deviation	0,124
AVG Group E	0,710
Standard Deviation	0,319

AED (6x1) Doctors, Nurses, Capacity, Staff Costs, Cost of Goods Sold and Materials Consumed and External Supplies and Services vs Emergency Departments 2015

AVG Group B	0,789
Standard Deviation	0,286
AVG Group C	0,742
Standard Deviation	0,207
AVG Group D	0,638
Standard Deviation	0,194
AVG Group E	0,351
Standard Deviation	0,052

AED (6x1) Doctors, Nurses, Capacity, Staff Costs, Cost of Goods Sold and Materials Consumed and External Supplies and Services vs Emergency 2016

AVG Group B	0,805
Standard Deviation	0,272
AVG Group C	0,751
Standard Deviation	0,207
AVG Group D	0,639
Standard Deviation	0,194
AVG Group E	0,359
Standard Deviation	0,054

AED (6x1) Doctors, Nurses, Capacity, Staff Costs, Cost of Goods Sold and Materials Consumed and External Supplies and Services vs Surgeries 2015

AVG Group B	0,721
Standard Deviation	0,216
AVG Group C	0,655
Standard Deviation	0,229
AVG Group D	0,677
Standard Deviation	0,249
AVG Group E	0,625
Standard Deviation	0,170

AED (6x1) Doctors, Nurses, Capacity, Staff Costs, Cost of Goods Sold and Materials Consumed and External Supplies and Services vs Surgeries 2016

AVG Group B	0,735
Standard Deviation	0,213
AVG Group C	0,665
Standard Deviation	0,239
AVG Group D	0,717
Standard Deviation	0,242
AVG Group E	0,601
Standard Deviation	0,165

FRONTIER (2x1) Doctors, Nurses vs Consultations 2015

AVG Group B	0,343
Standard Deviation	0,106
AVG Group C	0,547
Standard Deviation	0,244
AVG Group D	0,544
Standard Deviation	0,204
AVG Group E	0,842
Standard Deviation	0,175

FRONTIER (2x1) Doctors, Nurses vs Consultations 2016

AVG Group B	0,303
Standard Deviation	0,096
AVG Group C	0,545
Standard Deviation	0,228
AVG Group D	0,546
Standard Deviation	0,217
AVG Group E	0,816
Standard Deviation	0,197

FRONTIER (2x1) Personnel Costs, CMVMC vs Consultations 2015

AVG Group B	0,365
Standard Deviation	0,111
AVG Group C	0,507
Standard Deviation	0,168
AVG Group D	0,560
Standard Deviation	0,204
AVG Group E	0,845
Standard Deviation	0,171

FRONTIER (2x1) Personnel Costs, CMVMC vs Consultations 2016

AVG Group B	0,429
Standard Deviation	0,148
AVG Group C	0,566
Standard Deviation	0,211
AVG Group D	0,540
Standard Deviation	0,257
AVG Group E	0,779
Standard Deviation	0,216

FRONTIER (2x1) Doctors, Nurses vs ER 2015

AVG Group B	0,931
Standard Deviation	0,003
AVG Group C	0,931
Standard Deviation	0,010
AVG Group D	0,937
Standard Deviation	0,006
AVG Group E	0,933
Standard Deviation	0,007

FRONTIER (2x1) Doctors, Nurses vs Emergency 2016

AVG Group B	0,930
Standard Deviation	0,004
AVG Group C	0,936
Standard Deviation	0,008
AVG Group D	0,938
Standard Deviation	0,006
AVG Group E	0,935
Standard Deviation	0,006

FRONTIER (2x1) Personnel Costs, CMVMC vs ER 2015

AVG Group B	0,929
Standard Deviation	0,003
AVG Group C	0,928
Standard Deviation	0,010
AVG Group D	0,935
Standard Deviation	0,007
AVG Group E	0,932
Standard Deviation	0,005

FRONTIER (2x1) Personnel Costs, CMVMC vs Emergency 2016

AVG Group B	0,938
Standard Deviation	0,003
AVG Group C	0,941
Standard Deviation	0,008
AVG Group D	0,943
Standard Deviation	0,007
AVG Group E	0,940
Standard Deviation	0,005

FRONTIER (2x1) Doctors, Nurses vs Surgeries 2015

AVG Group B	0,446
Standard Deviation	0,099
AVG Group C	0,614
Standard Deviation	0,281
AVG Group D	0,762
Standard Deviation	0,188
AVG Group E	0,743
Standard Deviation	0,267

FRONTIER (2x1) Doctors, Nurses vs Surgeries 2016

AVG Group B	0,371
Standard Deviation	0,095
AVG Group C	0,566
Standard Deviation	0,269
AVG Group D	0,765
Standard Deviation	0,215
AVG Group E	0,765
Standard Deviation	0,197

FRONTIER (2x1) Personnel Costs, CMVMC vs Surgeries 2015

AVG Group B	0,652
Standard Deviation	0,140
AVG Group C	0,687
Standard Deviation	0,151
AVG Group D	0,777
Standard Deviation	0,115
AVG Group E	0,726
Standard Deviation	0,142

FRONTIER (2x1) Personnel Costs, CMVMC vs Surgeries 2016

AVG Group B	0,694
Standard Deviation	0,090
AVG Group C	0,733
Standard Deviation	0,130
AVG Group D	0,800
Standard Deviation	0,078
AVG Group E	0,801
Standard Deviation	0,054

The analysis shows that there is no common pattern in the financing groups with the highest standard deviation, which reveals that the greater volatility in the efficiency levels of each of the hospitals is not consistent according to the financing group, i.e. there is no definite trend, beyond the overall average, as to which financing groups are the most efficient.

In this context, and based on the above information, we can conclude that there is no relationship between the funding groups and the technical efficiency of the EPE Hospitals, i.e. the funding volumes are allocated without taking into account the efficiency levels of the EPE Hospitals.

Conclusion 15: In view of the results obtained, we can conclude that the financing group of the EPE hospitals is not a determining factor in terms of efficiency.

Chapter 9 - Conclusions

9.1 Systematising the analysis of results

Following the analysis of the results above, we reach out the following conclusions (C):

(C1) When we relate doctors and consultations, there is no cause-and-effect relationship between the resources available at the EPE Hospitals and the healthcare results.

(C2) When we relate nurses and consultations, there is no cause-and-effect relationship between the resources available at the EPE Hospitals and the care results seen.

(C3) When we relate doctors and nurses to consultations and surgeries, there is no cause-and-effect relationship between the resources available at the EPE Hospitals and the healthcare results.

(C4) When we relate doctors, nurses and all the operating costs to consultations, there is no cause-effect relationship between the resources available at the EPE Hospitals and the healthcare results.

(C5) When we relate doctors, nurses and all the operating costs to consultations, there is no cause-effect relationship between the resources available at the EPE Hospitals and the healthcare results seen.

(C6) When we relate doctors and nurses to consultations, there isn't always a cause-and-effect relationship between the resources available at the EPE Hospitals and the care results seen.

(C7) When we relate personnel costs and costs of goods sold and materials consumed to consultations, there is not always a cause-and-effect relationship between the resources available at the EPE Hospitals and the healthcare results.

(C8) When we relate doctors and nurses to emergency services, there isn't always a cause-effect relationship between the resources available at the EPE Hospitals and the results of the care provided.

(C9) When we relate personnel costs and costs of goods sold and materials consumed to emergencies, there isn't always a cause-effect relationship between the resources available at the EPE Hospitals and the healthcare results.

(C10) When we relate doctors and nurses to surgeries, there isn't always a cause-and-effect relationship between the resources available at the EPE Hospitals and the healthcare results.

(C11) When we relate personnel costs and costs of goods sold and materials consumed to surgeries, there is not always a cause-and-effect relationship between the resources available at the EPE Hospitals and the healthcare results seen.

(C12) In view of the results obtained, we can conclude that the organisational model underlying the EPE hospitals is not random in terms of the levels of efficiency found in the EPE hospitals, i.e. there is a correlation between the organisational models and the results obtained in terms of efficiency.

(C13) In view of the results obtained, we can conclude that the organisational model underlying EPE hospitals not only presents robust conditions for comparability between hospitals, hospital centres and local health units.

(C14) In view of the results obtained, we can conclude that the financing group associated with the organisational structure underlying EPE hospitals is not a determining factor in terms of efficiency.

(C15) In view of the results obtained, we can conclude that the financing group of the EPE hospitals is not a determining factor in terms of efficiency.

9.2. Final Conclusions

Based on the conclusions identified in point 11.1, we can answer the questions underlying this research:

(I) *Research Starting Question*

Is there an operational risk management concept for healthcare in Portugal?

Following the work carried out, I conclude that there is no concept of operational risk management for healthcare in Portugal;

(II) *Derived Questions*

- Is there a cause-effect relationship between the financial resources consumed by the EPE "Hospitals" and the healthcare results obtained?

Following the work carried out, I conclude that there is no cause-and-effect relationship between the financial resources consumed by EPE hospitals and the healthcare results obtained;

- Is information on operational and healthcare results disclosed transparently?

As a result of the work carried out, I have come to the conclusion that the accountability of the EPE Hospitals, in terms of form and substance, is absolutely miserable;

- Is the top management in a position to manage the "Hospitals" properly?

Following the work carried out and taking into account the results obtained, I conclude that the current context and mechanisms do not facilitate the proper management of hospitals, which, given the political nature, to the detriment of technical criteria, of board appointments, results in the desideratum we have had the opportunity to explain.

- Is the fairness of care real?

Following the work carried out, taking into account the results obtained and the information on waiting lists, I conclude that there is no equity in the provision of care, with the dichotomy between those who have health insurance and therefore access to private hospitalisation and those who don't being a decisive factor in the speed of access.

Research limitations

This work was carried out under extremely difficult conditions due to the lack of quality in the EPE Hospitals' financial statements.

Not only did this situation make it difficult to include more years in the analysis, but it also meant that the hypotheses could not be tested with more recent data. In addition, it was not possible to access the statutory auditors' reports for all the entities, which clearly affected the work.

So, while the limitations of the research allow us to better substantiate some of the conclusions, it is absolutely impossible to analyse the economic and financial performance of EPE hospitals on a regular and timely basis, which in itself is clearly a sign of a lack of transparency in the rendering of accounts in the state business sector, in this case in the health sector.

It should be noted that the conclusions could have been more robust if the sample had been more significant, and the work could have been more interesting if it had included care information on hospitals in public-private partnership, but it was not possible to access this information in a robust and comparable way.

With regard to Hospital Centres and Local Health Units, we did not take into account the number of organic units in each specific universe, so there are areas of comparability that could have been weighted by a coefficient to relativise this issue, but given that in this work we use the concept of efficiency in the context of DEA and FRONTIER, as a proxy for operational risk, it did not seem appropriate and/or desirable to add more complexity to the application of this model.

Lines for future research

As a precondition for this topic, it is essential that EPE Hospitals' accountability is (significantly) improved, with a view to obtaining timely and reliable information that allows this sector to be analysed on a regular basis.

We suggest the following as avenues for future research:

- Comparison of efficiency between public and private hospitals;

- Efficiency rankings by "hospital manager" and by political cycle;

- Analysing financing models in the context of hospital efficiency;

- Carrying out European benchmarking of public hospitals' healthcare activity;

- Economies of scale in each hospital management model;

- Economies of scale in the systematisation of a single hospital management model;

- Evaluation of efficiency as a proxy for operational risk in industrial sectors;

- Evaluation of efficiency versus employee motivation.

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Attachements

Attachement I – DEA test results

Attachement II – FRONTIER test results