

Family Health Units vs. Primary Healthcare Centres: Development of a discrete event simulation model to compare the performance of the two organizational models

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Abstract

There has been an increasing need for a more efficient organization of primary health care sectors within National Health Service (NHS) based countries. Several governments have attempted to stimulate efficiency improvements by means of innovative reforms in the organization of primary care units. This study proposes a tool to compare differences in performance between two primary care organizational models and to evaluate the impact of extending current reforms in the Portuguese primary care sector. Few studies in literature have quantified the impact of these recent primary care reforms. Thus, stochastic discrete event simulation models were built with the purpose of comparing the performance of the recently implemented family health units (FHUs) vs. primary health care centres (PHCCs). The simulation models were implemented in the Simul8 simulation software and embraced nineteen primary health care units from three municipalities of the Greater Lisbon sub-region: *Lisbon*, *Oeiras* and *Cascais*. Using the available information regarding the resources, production and costs of these units, the correspondent models were calibrated and validated. After the validation of the models, we compared the two organizational models and analysed with detail the possible gains or losses that result from the direct conversion of all studied PHCCs into FHUs. Key results follow: a potential increase of 10% in the ‘production’ of ambulatory consultations that might contribute for solving the problem of having population not allocated to a GP; there is an average reduction in the number of days for a consultation in 50%, meaning that substantial gains on scheduling appointments are achieved; regarding acute cases, there is a potential decrease on waiting times from the shifting of large PHCCs, and thus improving efficiency and quality; and finally, regarding the costs, results suggest an increase on overall costs for smaller PHCCs and the opposite (cost reductions) for the conversion of large PHCCs into FHUs. From all the obtained results, the final conclusion for the present study is that the ongoing Portuguese primary health care reform of implementing family health units leads to visible improvements on the accessibility, efficiency, quality and costs within this sector.

Keywords: Family health units, primary care, simulation, DES, performance indicators

1. Introduction

During the last years, there has been a growing attempt to stimulate different ways of management and organization in NHS countries. This need for a more efficient management should promote cost containment, despite maintaining the levels of quality and capacity of response. Within this movement, the Portuguese government has recently started a set of reforms that aimed at changing the organizational structure of the primary care sector by introducing a new type of organization structure based on family health units (FHU). Few studies in literature have quantified the impact of recent primary care reforms. This way, the development of tools that contribute to the evaluation of the actual system and enable the testing of new scenarios constitutes a surplus value for the respective decision-making authorities.

The aim of the present work was to evaluate one of latest and more innovative reforms, recently implemented by the Portuguese government within the primary health care sector – the creation of FHUs. Thus, a tool is proposed with the goal of comparing the differences in performance between the two existing types of primary care units (primary health care centres and family health units) and to

evaluate the impact of extending the current reforms in the Portuguese primary care sector.

Regarding the goals of the present work, two discrete event simulation models were defined taking into account the correspondent organizational characteristics of primary health care centres and family health units. A set of key performance indicators (KPI) were used in these models, allowing us to have a closer insight of the current situation in these units and comparing the differences between these organizational models. The indicators used can be grouped in four categories: queuing times, percentage of use of personnel, number of consultations per professional and costs.

After presenting the conceptual models, these same were implemented on a specific discrete simulation software – the Simul8 software [1]; Then they were applied to a case study that included nineteen primary health care units – twelve primary health care centres and seven family health units – from three municipalities of the Greater Lisbon sub-region: *Lisbon*, *Oeiras* and *Cascais*. Using the available information regarding the resources, production and costs of these units, the correspondent models were calibrated and validated.

2. Context and case of study

Last years, there has been an increasing need for a more efficient organization and management in the primary health care sector.

In 2004 the Portuguese government presented the National Health Plan from 2004 to 2010. It represented the instrument that should define the strategic orientations of health for that period, clearly pointing to a need of strengthening the primary care sector's role (for promotion and prevention).

With the 2005 elections, the government has changed. Despite the 2004 National Health Plan was maintained, several other changes were made. The top priorities defined by this new government were: the primary health care reform, the implementation of the national network of integrated continued health care and the financial sustainability of the NHS [2]. Regarding the Portuguese primary health care, the reforms suggested mainly derived from:

Summary of the main challenges within the Portuguese primary health care sector:

- Small and inadequate amount of doctors in some regions and specialties (e.g. GPs), lack of nursing personnel and the imbalance of primary care physicians versus hospital specialists are some of the visible signs of the weakness of public health policy in the field of human resources.
- The retirement in the near future of many physicians will create a shortage, as past policies did not ensure a sufficient intake to replace them. If current trends prevail, absolute numbers will become an issue in the future. It is imperative a better use of the existing human resources.
- The crescent increasing percentage of urban population (mainly suburban), between 1980 and 2004 together with the lack of planning within the health care network, has been leading to a very high number of citizens without a GP, to unnecessary overuse of hospitals' emergency services [3] and higher dissatisfaction within patients and medical personnel.

Thus, in 2006, regulations were made in order to launch and implement new primary health care units – family health units (FHU). These units should have organizational, functional and technical autonomy, based on multi-professional teams, formed by general practitioners, nurses, managers and other professionals in order to improve the accessibility and reconfigure the primary care centres [4]. Additionally, it was established a model of incitement not only to doctors but to all FHU professionals, rewarding the individual and collective performance. With the Law 298/2007 two types of incentives were created: financial and institutional. Both could be achieved depending on the number and characteristics of the patients assigned to each GP's list, the number of specific vigilant activities on more vulnerable groups, enlargement of the period of assistance and other additional services [5].

The present work had the specific goal of testing whether this reform's aim of implementing FHUs leads to visible

improvements in the accessibility, efficiency and quality in primary health care. Moreover, because this reform had not been applied yet to all primary health care centres, an additional scenario of testing a complete conversion of primary health care centres in FHUs was tested

3. Review of ongoing reforms in the primary health care sector and their impacts

Three studies reviewed the latest reforms within the Portuguese primary health care sector [4, 6, 7]. Biscaia et al. have analysed the satisfaction of patients and physicians as well as the priorities for the current primary health care reform [6]. Results suggest that one of the most critical points of the present reform is the improvement of patients' and professionals' satisfaction mainly through a closer relationship between these two entities. Another study has analysed the cost differences between primary health care centres and Experimental Remuneration Regimen (ERR) units [8]. It consisted on an econometric analysis that confirmed the existence of a self-selection trend for ERR units' physicians to carry out a higher number of consultations. Moreover, it was estimated an overall reduction for these units' costs (resulting from an increase on costs with medical personnel compensated by savings within drug prescriptions and complementary diagnosis tests). This study was later completed by an econometric analysis of the costs, remuneration and incentives associated with family health units [4]. Results pointed for an increase in costs associated with the remuneration and incentives' system of physicians. Pisco [9] also conducted a study about the present reconfiguration of the primary health care sector and evaluated the necessary steps in order to successfully implement primary health care centres' groups. A more recent study has focused upon the problems and successes from implementing new FHUs [10], listing the set of successes and areas where an intervention was needed in order for this reform to be fully successful. Regarding equity, previous studies demonstrated that despite the Portuguese health care system's orientation for an equal access to the NHS, to health promoting commodities and to both public and private health care [11], the degree of pro-rich inequity in doctor use in Portugal is one of the highest among the studied 21 OECD countries [12]. Regarding the efficiency, it was referred in [3] that positive signs from the ongoing reform of implementation of FHUs started to be visible at the end of 2007, namely the reduction of consultations' demand outside the normal working period of health care units, a closer relationship between the patient and the physician and a higher degree of satisfaction and motivation among users and medical personnel. Recently, a stochastic discrete event simulation model to study the organisation of primary and secondary care services was recently proposed [13]. Results showed that although the current system is not prepared to cope with a rise in demand, other tested scenarios indicate that there is room for primary care reforms to increase the system's efficiency and accessibility, while lowering total

costs. It is important to emphasize that from all the studies referred above only the last one used simulation as a tool.

Regarding important ongoing primary care reforms, similar to the ones being implemented in Portugal, within NHS and non-NHS foreign countries there is the example of some provinces in Canada. Since 1998, family health networks have been created to improve the deliver of primary care, creating groups of physicians, supplemented with a nurse-staffed telephone service 24 hours a day, so as to deliverer comprehensive care while promoting a stronger doctor-patient relationship [14]. Additionally, over the last decade, United Kingdom’s governments’ policies have placed a common increasing emphasis on the notion of a primary-care-led NHS, with an attempt to shift power and resources from secondary to primary care [15]. Initiatives such as fundholding, total purchasing pilots, Primary Care Groups (PCGs), and the pilot salaried schemes have been attempts to shift resources to the primary and community sector, and away from the hospital sector [16].

4. Methods to analyse the impact of primary health care reform and the proposed simulation model

4.1. Available methods to analyse the impact of the primary health care reform

Several different methods are available to analyse a system and the impact of new policies on it (Figure 1).

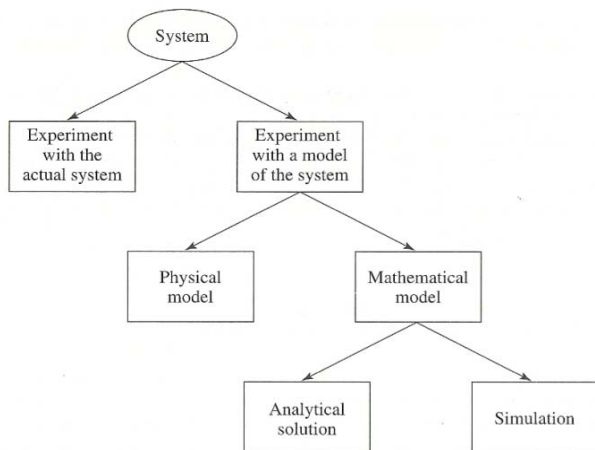


Figure 1: Ways to study a system [17]

From the analysis of the possible existing ways for the purpose of the present work (compare the performance of family health units vs. primary health care centres) we chose to use simulation as the tool.

In order to describe our system faithfully, random variables were considered. Besides demand, the length and the waiting time for a consultation were considered stochastic elements. Moreover, the events of this system were described as occurring in individual and isolated instants of

time which made the model discrete. For these reasons, we proposed to use a dynamic, discrete event stochastic model, also known as DES.

Reviewing the literature, we found that simulation models were being applied to several areas. Within health sector, it was distinguished [18]:

- 1) Epidemiology, health promotion and disease
- 2) Health and health care systems design:
- 3) Health and health care systems operation:

Despite all the reviews carried out, no national or international studies were found concerning directly the use of a discrete event simulation models to evaluate primary health care organizational reforms. The closer we got, were some studies that describe how simulation could be used to new test alternatives and to choose a solution to significantly reduce the length of stay for patients within an emergency department [19]; simulation models that were used in the design of appointment systems to minimize patient waiting times [20] and a tutorial that presented example applications of simulation in some specific services within the health care sector [21]. Concerning the Portuguese reality, a stochastic discrete event simulation model to study the organization of primary and secondary care services, with reference to the context of the Portuguese NHS, was recently proposed [13].

Thus, our study differed from previous studies in that we compared two organizational models of primary care using simulation models, and quantify some impacts of extending the FHU model to the primary health care sector in Portugal. Given that this research answers to policy questions that are of extreme relevance to policy makers, we consider that our work has the potential to contribute to enhancing research in health services.

4.2. Proposed Simulation Models

4.2.1. Studied Region

Greater Lisbon is a Portuguese NUTS III sub-region integrated in the Lisbon region (Figure 2). This sub-region is formed by 9 municipalities: *Amadora, Cascais, Lisboa, Loures, Mafra, Odivelas, Oeiras, Sintra* and *Vila Franca de Xira*.

The chosen region in the present work embraced three municipalities of the Greater Lisbon sub-region: *Lisboa, Oeiras* and *Cascais*. As we can observe, these three municipalities are adjacent to each other forming a line along the Tagus river.

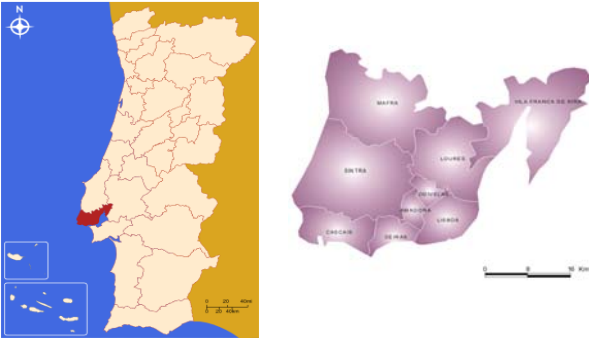


Figure 2: Left: Portuguese NUT III regions. Right: Greater Lisbon sub-region. [22]

The main reason why this set of units was selected is related with fact that the Greater Lisbon region is an urban zone with a high population density and has been characterized by a population growth above the national average (mainly in the suburban zone) during the last six years [23]. Thus, this high density and growth have been contributing significantly to an increasing pressure on health care demand in these sub-urban regions, which made highly interesting and pertinent to choose them for the purpose the present work. Moreover, as we observed in Figure 2, the units we chose are located along a continuous coastline that is constituted by populations with different characteristics and consequently by different health care needs (e.g. different demand for consultations).

4.2.2. Description of the Conceptual Model

From the previously described region, we have selected nineteen primary health care units for our study: twelve PHCCs and seven FHUs.

In figure 3 it is represented a general diagram of the model of a PHCC and of a FHU. The associated fluxes are shown by four different colours of arrows: red, yellow, green and blue. The red arrows represent the patient entering in the primary health care unit (the initial contact), the yellow arrows represent the internal flow of patients inside it, the green arrows describe the exiting of patients from the unit and the blue arrows represent the model's type of remuneration.

Summary of the differences between the organisational model of a Primary Care Centre and a Family Health Unit:

Regarding the appointment scheduling, in FHUs, besides the possibility to set up a consultation for physicians there is also, contrarily to PHCCs, scheduling for nursing care; for physician's appointments

Both in PHCCs and in FHUs, the consultations with the GP are previously set up for a specific day and hour. However, in FHUs there are no patients without an associated physician. This means that, in a FHU, patients are taken care and treated by the same GP the majority of the times. On rare occasions, when that does not happen, there is inter-substitution between physicians, potentially

leading to higher level of production and satisfaction to the patient.

Regarding acute situations in some primary care centres, there might exist a service for acute situations named Complementary Service. This service has its own physicians, working on predetermined shifts. This means that this service is only available in certain days and at certain time periods. On the other hand, there is the so called Urgent/Day Appointment in FHUs. It is also a service designed for acute cases. Despite working differently – due to some gaps that exist, intentionally, in the physician appointment schedule – these acute cases can be taken care of on those gaps, with preference by the GP responsible for the patient. If the correspondent GP is not available, another GP might take care of that patient (inter-substitution). This way, as long as the FHU is opened, acute cases might be taken care of if resources are available in the FHU. Usually, FHUs do not operate during the weekends, which implies that patients under acute situations will need to access the correspondent primary health care centre or hospital.

For nursing care, the most significant difference between primary care centres and FHU is the possibility on FHU to set up an appointment to a specific day and hour. In primary care centres patients are taken care of in a first in, first out logic.

Finally, regarding costs, in primary health care centres, there is a prevalent type of remuneration method. This method is ruled by the public administration's legislation, usually corresponding to an exclusive 42 hours/week period salary. As previously explained, FHUs can be organized according to two main models: either the personnel's remuneration is ruled by the public administration's legislation, corresponding to an exclusive 35 hours/week period (Model A) or the remuneration process is formed by two components: a fixed and a variable one. The fixed component corresponds to the legislated remuneration for an exclusive 35 hours/week period and the variable one corresponds to all supplements that derive from the worker's and FHU's performance (Model B).

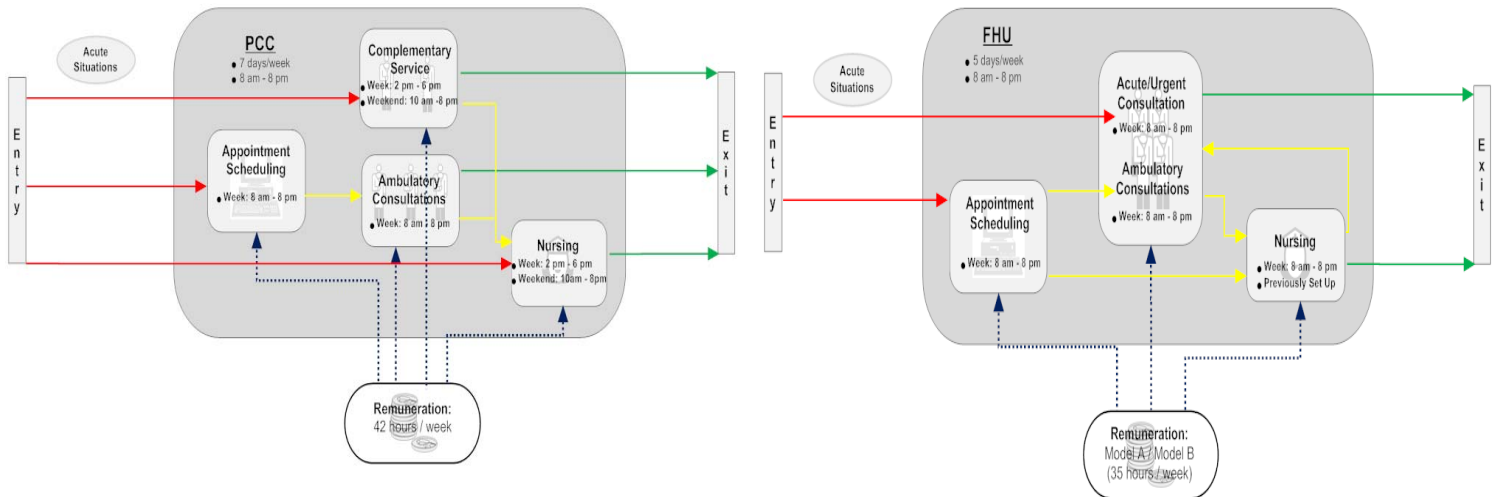


Figure 3: Left: Conceptual model of a primary health care centre. Right: Conceptual model of Family Health Unit

How to transform a Primary Health care Centre into a Family Health Unit

The present study consisted on the development of discrete event simulation models to compare the performance of two types of primary health care units: family health units vs. primary health care centres. After this comparison, we aimed at testing the following scenario: what would happen in the system if all the primary health care centres would be converted into family health units? This scenario tried to capture the possible changes in efficiency, quality and costs in the system that might result from the complete application of the current primary health care reform defined by the Ministry of Health.







The process of this conversion is now explained. First, depending on the size of primary health care centres, each of them is divided into smaller subunits (with 6 to 9 physicians, 6 to 9 nurses and in average 5 managers / receptionists). Then, in each of these smaller subunits, the Complementary Service is closed, using the physicians that work there exclusively for ambulatory consultations. This way, as it was previously explained, acute situations are taken care of during all day, as long as the FHU is opened, and usually by the respective physician. So, a higher concern that every patient is taken care of and treated by his own GP both for ambulatory consultations and in acute situations becomes a priority in the FHU. A change in the physicians', nurses' and managers' remuneration is also applied. For GPs, for example, there is a switch from a 42 hours/week schedule without incentives to a 35 hours/week schedule without incentives (Model A) or with incentives (Model B). The last change corresponds to consultations for nursing care becoming previously set up instead of having patients appearing unexpectedly in the system.

4.2.3. Computational Implementation

In order to implement a simulation model, among several available packages, the Simul8 software was chosen and

used [1]. This is a high power but user friendly simulation package.

A Simul8 simulation model corresponds to an interaction of a number of objects and lines joining them. The main objects used in a Simul8 language are: Work Items, Work Entry Points, Storage Bins, Work Centers, Resources and Work Exit Point. The lines that join them represent the flux and relations between the objects. In order to implement these relations in our Simul8 simulation model, a Visual Logic programming language was used. Hundreds of routines (rules that are programmed to control the behaviour of each object within the system) were implemented on the referred software, ruling every single behaviour of every object.

| | |
|---|--|
|  | <u>Work Items</u> – corresponds to the central object in the organization being simulated.. (E.g. patients) |
|  | <u>Work Entry Point</u> – is a place where work to be done appears for the first time in the model. (E.g. patients entering the primary care centre) |
|  | <u>Storage Bins</u> – is a place where work to be done can wait until the appropriate resources or work centers are available. (E.g. patients waiting for the consultation at the waiting room) |
|  | <u>Work Centers</u> – is the place where the work takes place. Usually, this work takes up time and sometimes requires the availability of resources. (E.g. physician's cabinets or nursing rooms) |
|  | <u>Resources</u> – are items in the simulation model which are required at work centers in order for them work to work. Work centers can not start work until a work item is available and the specific resources are also available. Resources can be available for only part of the time a simulation is running, making use of shift patterns to describe their availability. (E.g. Physicians, Nurses and Managers) |
|  | <u>Work Exit Point</u> – is the place where work that is complete leaves the model. (E.g. patients leaving the primary care centre) |

The computational implementation of a primary health care centre and a family health unit is now presented. In figures 4 and 5 it is represented a specific PHCC and FHU from our case study, with particular data (PHCC Benfica and FHU Rodrigues Migueis respectively). What it is truly important in this figure are relationships that are established (equal to all the other PHCCs and FHUs that

we have modelled) and not the specific number of personnel that are shown. Each primary health care unit was computationally implemented within the same relations but according to the correspondent number of receptionists, physicians and nurses.

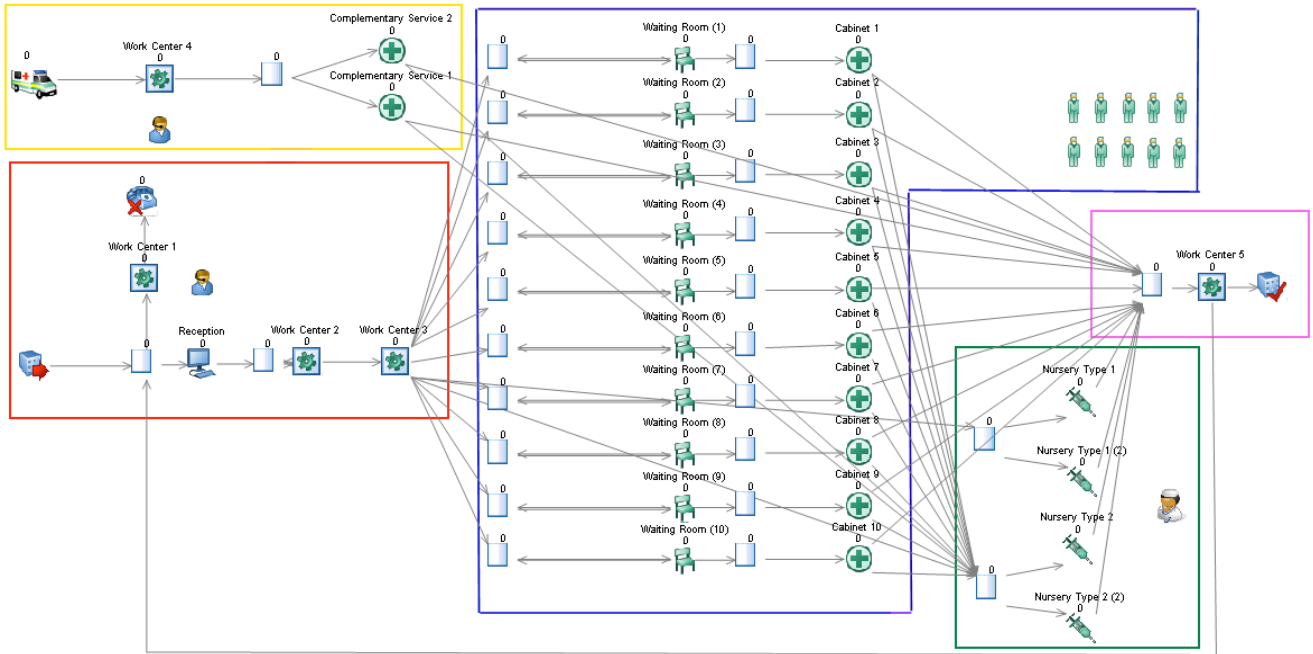


Figure 4: Computational implementation of a primary health care centre. It is important to notice that this particular figure corresponds to one of the studied primary health care centres. However, all primary health care centres studied have a similar structure, only changing the particular number of Cabinets, Physicians, etc.

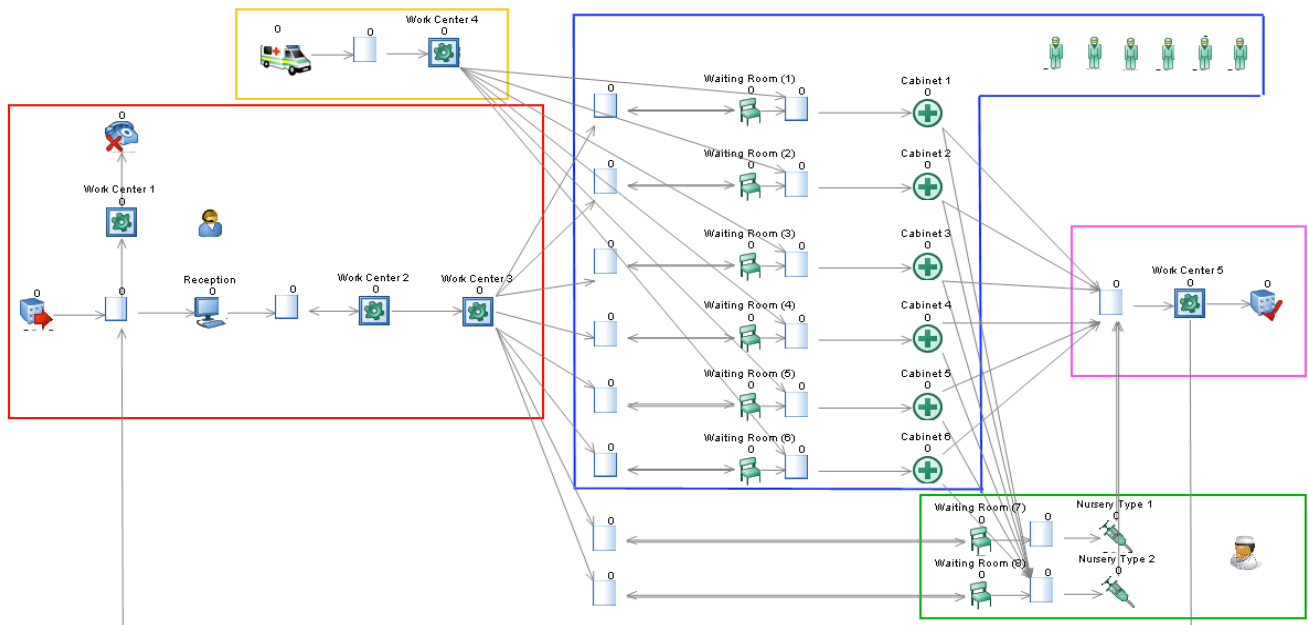


Figure 5: Computational implementation of a Family Health Unit. It is important to notice that this particular figure corresponds to one of the studied FHU. However, all FHUs studied have a similar structure, only changing the particular number of Cabinets, Physicians, etc.

In this subsection, both the parameters (used to calibrate our models) and the key performance indicators (set of indicators used to compare both the FHU's and the PHCC's models) are described (Table 1 and 2):

| | Parameter | Value | Source of information |
|---------------|---|---------------------------------|---|
| Entry | Inter-arrival time | Average Distribution | <ul style="list-style-type: none"> ▪ Statistics 2006 (Administração Regional de Saúde Lisboa e Vale do Tejo - 2007) ▪ Activity Reports of each health care unit ▪ Direct Contact and Questionnaires to each health care unit ▪ Cuidados de Saúde Primários - Actividade 2004 (Administração Regional de Saúde Lisboa e Vale do Tejo - 2005) |
| | Distribution Type of Consultation | Probability Profile | |
| | Distribution Number of the GP | Probability Profile | |
| Internal Flow | Distribution Days for the Consultation | Normal Distributions | |
| | Doctor's Schedule | - | |
| | Nurse's Schedule | - | |
| | Distribution of Adult Consultation's Duration | Log Normal Distribution | |
| | Distribution of Other Consultation's Duration | Log Normal Distribution | |
| | Distribution of Nursing's Type 1 Duration | Average Distribution | |
| | Distribution of Nursing's Type 2 Duration | Average Distribution | |
| | Cost per consultation with personnel | PHCCS (13,25€) FHUs (16,32€) | [8] |
| | Cost per consultation with diagnosis tests and other treatments | PHCCS (39,20€) FHUs (29,20€) | [8] |

Table 1: List of the parameters used in the model

4.3. Validation of the proposed model

The process of validating and calibrating of the model was divided in two parts. Initially, in order to queues (and other aspects in the simulation) get into the typical conditions of running in the real system, a warm-up period was used. It corresponds to the time that the simulation will run before we start collecting results. After some research and several attempts, a warm-up period of 52 weeks (one year) was set. The reason for this value is because, after one year, parameters like queues and waiting times were stable, i.e. they approached a certain value. The second part was the setting of the collection period. It represented the amount of time each model is run before it returns the results (in the present work we set it to one working year - 50 weeks).

As it was said before, each of the three studied municipalities (*Lisbon, Oeiras, Cascais*), is formed by several primary health care centres and FHUs. A model of each one of these health care providers was built and run separately using a trial of five runs (generating different random numbers). The number of runs directly affects the accuracy and the time demanded to run the model. Thus, a compromise was made in order to run our models with

| | Indicator | Type of indicator |
|--------------------------------------|--|------------------------|
| Appointment Scheduling | Average waiting time to see the Receptionist (min.) | Efficiency and Quality |
| | Average number of days for a consultation with the physician (days) | Efficiency and Quality |
| | Average percentage of use of Receptionists (%) | Efficiency |
| General Practitioner's Consultations | Average number of Consultations per Physician | Efficiency |
| | Average time spent in the waiting room (min.) | Efficiency and Quality |
| | Average percentage of use of Physicians (%) | Efficiency |
| Acute Consultations | Average number of acute/urgent consultations per physician | Efficiency |
| | Average waiting time for an acute/urgent consultation (min.) | Efficiency and Quality |
| Nursing Consultations | Average number of nursing consultations per nurse | Efficiency |
| | Average time spent in the waiting room for diabetes, child or maternal consultations (type 1) (min.) | Efficiency and Quality |
| | Average time spent in the waiting room for vaccinations or other types of treatments (type 2) (min.) | Efficiency and Quality |
| | Average percentage of use of Nurses (%) | Efficiency |
| Costs | Average total costs (€) | Costs |
| | Average costs with Personnel (€) | Costs |
| | Average costs with diagnosis tests and other treatments (€) | Costs |

Table 2: List of the key performance indicators used in the model

good accuracy and within a reasonable amount of time. The models were run on an Intel® CPU 1.60 GHz, with 2.00 GB of RAM, and using both the Simul8 13.0 and the Excel 2003 software.

Thus, comparing whether the real values were within the intervals returned by the models allowed us to verify the validity of the proposed models. These models were then used to test the impact of new scenarios.

5. Results and Scenario Testing

5.1 Results for the year 2007

In this section, the results for 2007 are shown. It is important to refer that all these results were estimated by the model and no previous information about them was known, i.e. these are indicators suggested by the simulation models we have run.

| Appointment's Scheduling |
|---|
| <ul style="list-style-type: none"> ▪ In FHU, patients have to wait a lower number of days in order to have a consultation (~ 14 vs. ~ 30 days). ▪ Contrarily to primary health care centres, in FHUs, the number of waiting days for a consultation is not affected by the size of the health care unit. |
| <ul style="list-style-type: none"> ▪ <u>Overall Performance Comparison</u>: FHUs have higher efficiency and quality in the scheduling appointment process. |
| Physicians' Consultations |
| <ul style="list-style-type: none"> ▪ In FHUs, the average number of consultations per physician is higher than in primary health care centres. ▪ The average time a patient spends in the waiting room is considerably lower in FHU. ▪ The average percentage of use of physicians is similar in primary health care centres and FHUs. |
| <ul style="list-style-type: none"> ▪ <u>Overall Performance Comparison</u>: There is a higher efficiency and quality associated to physicians' consultations in FHU. |
| Acute/Urgent Case |
| <ul style="list-style-type: none"> ▪ Primary health care centres and FHUs have similar average waiting times for an acute/urgent patient (~ 14 minutes) |
| <ul style="list-style-type: none"> ▪ <u>Overall Performance Comparison</u>: No significant differences between primary health care centres and FHUs' acute/urgent performance |
| Nursing Consultations |
| <ul style="list-style-type: none"> ▪ In FHUs the average time in the waiting room for a nursing consultation is lower, especially for type 2 consultations. ▪ Similar percentage of use of nurses in primary health care centres and FHUs. |
| <ul style="list-style-type: none"> ▪ <u>Overall Performance Comparison</u>: Slightly higher efficiency and quality on FHUs' nursing consultations. |
| Costs |
| <ul style="list-style-type: none"> ▪ The average costs with personnel are slightly higher in FHUs. ▪ In FHUs, the costs with diagnosis tests and other treatments is significant lower. |
| <ul style="list-style-type: none"> ▪ <u>Overall Performance Comparison</u>: It was not possible to find new results about differences in cost's performance between primary health care centres and FHUs |

5.2 Scenario Testing

The use of simulation models allowed for testing new ideas and hypothesis of behaviour in the primary care system. As described above, the developed models can be used to test the impact of policies. We present now the results from converting PHCCs into FHUs.

This scenario corresponds to a policy of the MoH of extending the conversion of PHCCs into FHUs in Portuguese primary health care sector. During the last three years, several family health units have been created, reaching the present total number of 143. However, these FHUs constitute a small percentage of the total universe of primary health care units. This way, trying to analyse the consequences of this policy, might constitute an important basis to understand whether the current reform effectively leads or not to the goal of improving the accessibility and quality within the primary health care sector.

From the initial 12 primary health care centres (PHCCs), that we selected, we had, after the conversion into FHUs, a total number of 26 Converted FHUs. This corresponds to what was described as splitting each large PHCCs into smaller subunits of FHUs, maintaining however the total number of working personnel. Thus, when we present the results of these Converted FHUs' performance indicators, despite of the 12 observations (points), each of them corresponds to a different number of observations, i.e. each point on the chart is the result of the over positioning of several points (the several constituting FHUs).

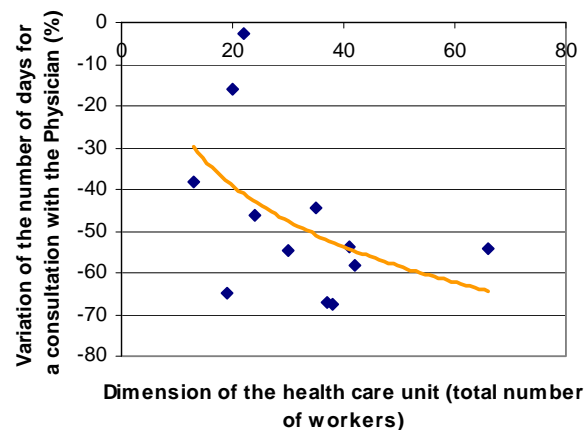


Figure 6: Variation of the number of days for a consultation with the physician vs. Dimension of the health care unit

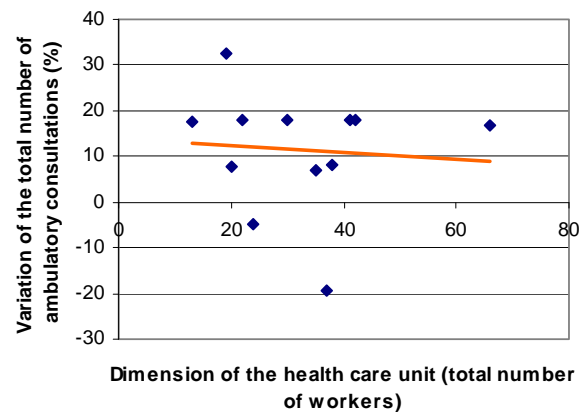


Figure 7: Variation of the total number of ambulatory consultations vs. Dimension of the health care unit

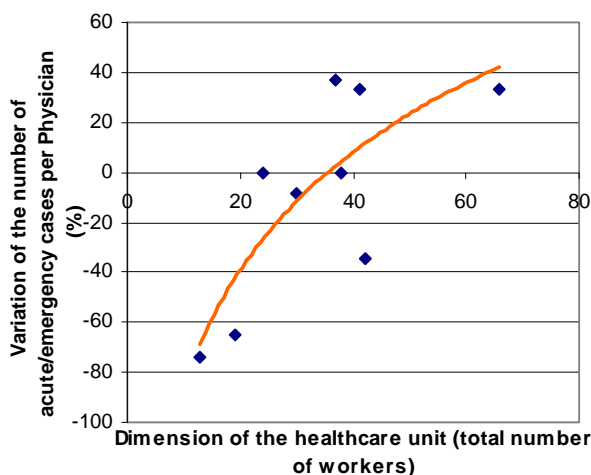


Figure 8: Variation of the total costs vs. Dimension of the health care unit

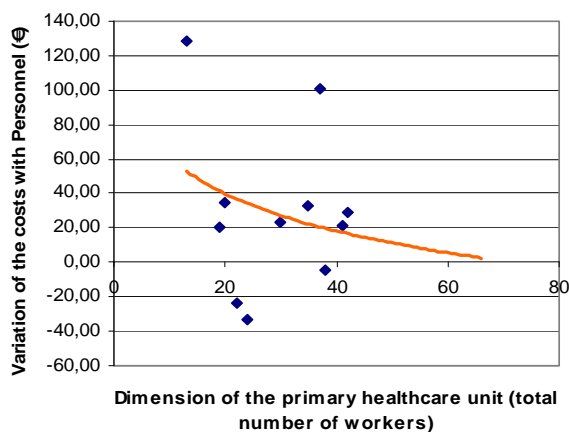


Figure 9: Variation of the costs with personnel vs. Dimension of the health care unit

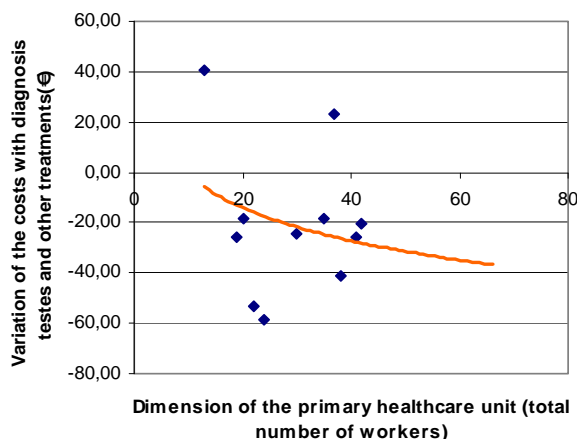


Figure 10: Variation of the costs with diagnosis tests and other treatments vs. Dimension of the health care unit

The main results that derive from extending the FHU organizational model to our sample of primary care units can be summarized into the next table.

| Appointment's Scheduling |
|--|
| <ul style="list-style-type: none"> There is a significant reduction on the average number of days for a consultation, after converting PHCCs into FHUs. The larger the initial dimension of primary health care centre, the larger that reduction, ranging from some weeks to more than a month. |
| Physicians' Consultations |
| <ul style="list-style-type: none"> With the conversion of primary health care centres into FHUs, the potential capacity of these new health care units for ambulatory consultations increases on around 10%. The conversion of small primary health care centres into FHU leads to an increase on the patient's average waiting time. For larger primary health care centres, the same change leads to a lower patient's average waiting time to be taken care of. There is a slight increase in the percentage of use of physicians with the change into FHU – this indicator is increased to around 86% of use of physicians. |
| Acute/Urgent Case |
| <ul style="list-style-type: none"> For small primary health care centres there is a reduction of the capacity for total number of acute/urgent consultations when they change into FHUs. The larger the primary health care centres, the larger the increase in answering to acute cases. Despite these converted FHUs do not operate during the weekends, results suggest that shifting from a primary health care centre into a FHU allows for efficiency gains within the acute/emergency care sector. |
| Nursing Consultations |
| <ul style="list-style-type: none"> Converting small primary health care centres into FHUs leads to a significant increase on the capacity for carrying out nursing consultations. Converting larger primary health care centres into FHUs presents no significant changes. There is an overall reduction on the waiting time for nursing consultations, especially for type 2 consultations (consultations for vaccination or other type of treatments). This means that setting up nursing consultations (one of the most radical changes between primary health care centres and FHU) is expected to lead to efficiency gains. The shifting into FHUs leads to increased efficiency on the use of nurses in small primary health care centres and to no significant changes in larger PHCC. |
| Costs |
| <ul style="list-style-type: none"> There is a small increase in the overall costs from the shift of smaller PHCC but, the bigger these units are more significant is the reduction on these costs (results suggest a potential reduction on overall costs on about 50% for bigger units). The higher the number of consultations carried out by physicians and nurses the greater the cost reduction. |

6. Conclusions

The purpose of the present thesis was to evaluate one of latest and more innovative reforms recently implemented by the Portuguese government in the primary health care sector – the creation of family health units. Our study has compared the performance of two primary care unit organizational models (PHCC vs. FHU) and analysed

which gains and losses in the system might appear with the conversion of PHCC into FHU. Discrete event simulation models were developed in order to compare the performance of these FHUs vs. PHCCs.

In this thesis we started by characterising the Portuguese primary care system and we have reviewed evidence on studies analysing the impact of primary care reforms. We found very few national or international studies evaluating organizational models.

Due to the high complexity around the definition of models representing the processes of PHCC and FHU, we made use of assumptions and simplifications. We have built conceptual models for PHCC and FHU and implemented them in the Simul8 software program; and we have applied these models to PHCC and FHU from three municipalities of the Greater Lisbon sub-region: *Lisbon, Oeiras* and *Cascais*. Throughout the development of this thesis, some specific challenges were faced, namely the difficulty in obtaining official and reliable data to calibrate the models' parameters and to validate the model. The collected information was sometimes either incomplete or presented in a format that made it difficult the process of calibrating and validating the several constituents of the models. The development of future simulation models requires the use of higher quality data. Finally, it is important to refer again that the reliability of all the results that were presented depends on whether the behaviour of the tested FHUs is similar to the ones that were used as reference.

After the calibration and validation process, estimates of key performance indicators were analysed for both the organizational types of primary care units. Results suggest that in FHUs, patients have to wait a lower number of days in order to have a consultation (~ 15 vs. ~ 30 days). Moreover, the average time a patient spends in the waiting room is considerable lower in FHU.

We have also tested the impact of a meaningful policy scenario: we have analysed the expected impact of extending the FHU model to our sample of primary care units, assuming that they might be converted into FHU similar to the ones already existing. The results obtained for this reform suggest that the key impacts are: a potential increase of 10% in the 'production' of ambulatory consultations that might contribute for solving the problem of having population not allocated to a GP; there is a reduction in the number of days for a consultation in 50%, meaning that substantial gains on scheduling appointments and consequently gains in access of populations to care are achieved with this reform; regarding acute cases, we can conclude that there is a potential decrease on waiting times from the shifting of large PHCCs, and thus improving efficiency and quality in health care delivery; finally, regarding the costs, results suggest an increase on overall costs for smaller PHCCs and the opposite (cost reductions) for the conversion of large PHCCs into FHUs.

Summing up, and being aware of the limitations of this study, two main conclusions can be highlighted from this thesis. First, comparing the performance of FHUs vs.

PHCCs, FHUs seem to perform better on efficiency, quality and cost grounds. In comparison to PHCC, FHU allow for improvement in the processes of scheduling appointments and delivering physician's consultations. Additionally, the conversion of PHCCs into FHUs suggests gains in the processes of scheduling appointments, of delivering physicians' and nurses' consultations, as well as in cost savings. These gains seem to be stronger for the conversion larger PHCC into FHU.

From all the obtained results, the final conclusion for the present study is that the ongoing Portuguese primary health care reform of implementing family health units leads to visible improvements on the accessibility, efficiency, quality and costs within this sector.

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