A Multiple Criteria Satisfaction Analysis tool for measuring patients' satisfaction with Portuguese secondary care: the case of inpatient services

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Abstract

Healthcare is a multidimensional, challenging, fast-changing and complex sector. In an increasingly competitive market of healthcare industries, and with the central goal of improving patients' quality of life, it is paramount to achieve high, or excellent, ratings on patient satisfaction. The present study's objective is to evaluate patients' satisfaction concerning the Portuguese secondary healthcare within the NHS, in particular, the inpatient service. More specifically, this study aims at determining which attributes patients value the most in this service valence, at classifying each satisfaction criterion (featuring the hospital attributes), at discovering patients' demanding nature and, lastly, at identifying potential improvements, priorities and opportunities for the Amato Lusitano hospital to improve its performance. To do so, a Multicriteria Satisfaction Analysis (MUSA) method is employed. The main advantage of this linear-programming based model is that it fully considers the qualitative form of customers' judgements and preferences, as they are expressed in the satisfaction questionnaires. Results have shown that the auxiliaries are the most important service feature for hospitalized patients, especially in terms of their readiness and availability. Furthermore, aspects such as the number of visits, the information on patient's clinical status and health advising and teaching have been pointed out as first priorities within the considered service. However, larger samples of patients must be considered for further research and the possible extensions of MUSA must be explored.
Keywords: Inpatient service, Portuguese NHS, Patient satisfaction, Multicriteria Satisfaction Analysis.

1. Introduction

The healthcare sector is a delicate one and it is continually facing substantial challenges of all kind, namely the ones related to demographic changes. Over the years, the unbalanced distribution of the population, the increased migration movements and the unhealthy ageing of the population have had a considerable impact on the management of healthcare systems, alongside with the resources struggle resulting from the international financial and economic crisis that was felt in the past few years. The ultimate goal of all healthcare systems is to protect, improve and promote the population's health, while optimizing costs, improving efficiency and broadening both the access and the quality of the services provided.

In line with this, healthcare managers must master their skills on performance evaluation and decision-making. More importantly, in the increasingly competitive market of healthcare industries, managers and policy makers must recognize patients as the most valuable source of information, and should focus on achieving high, or even excellent, ratings of patient satisfaction [2]. In particular, if the system is Beveridge-based, one should expect that citizens, who finance most of the healthcare provision, demand, in exchange, for effective and efficient services, equity on access, low waiting times, and the overall exceeding of their own expectations [7]. It is paramount, however, to note that patients might be unable to correctly and non-emotionally evaluate the quality of care, given the severity and/or complexity of their illness, and their judgements may be biased by this, and other, factors.

Generally, the performance evaluation is mainly devoted to the emergency room, which undoubtedly needs to be more efficient and organized. However, there are (other) areas in which this task should be performed. Despite its importance, measuring patients' satisfaction with regard to secondary healthcare is something that is rarely addressed. Trying to fill this gap, the present study aims at evaluating the hospital's performance on the inpatient

service valence. The main goal is to identify the factors which deserve more attention, when trying to enhance patient satisfaction, and which areas of low performance should be tackled first. In line with this, a simple questionnaire is distributed and patients are asked to make a set of independent judgements, with regard to a set of criteria/subcriteria representing the inpatient service's quality. A Multicriteria Satisfaction Analysis is employed, the MUSA method, and at the end it is expected that one can: (1) determine the value of each satisfaction criteria, (2) know what patients value the most within this particular service, (3) classify each criterion, (4) assess patients' demanding nature and lastly (5) identify potential improvements, priority areas and opportunities for improvement.

2. Background

This chapter provides an overall description of the problem that motivated the present study. First, the current state of the Portuguese healthcare sector is explored, including a brief description of the Portuguese NHS. Next in order, some key points from the literature review are presented, namely the not yet fully defined concept of satisfaction. Lastly, the development of the employed mathematical model is detailed, alongside with some concepts and definitions.

2.1. Portuguese health sector

Similarly to other European countries, the Portuguese health sector suffers from profound demographic changes and health inequalities remain one of its major challenges. The population has become mainly concentrated in the metropolitan areas of Lisbon and Oporto, and along the coast, leaving an increasingly sparse and elderly population inland. Furthermore, the lack of coordination between providers, multiple sources of financing and the excessive centralization of some services were some of the main issues faced by the Portuguese health sector, back in 1970.

Following the democratic revolution of April 25$^{\text{th}}$ of 1974, Portugal underwent an authentic restructuring process at all levels. As a consequence, the Portuguese National Health Service (NHS) was created in 1979, following the principle of every citizen's right to health, embodied in the 1976 Constitution of the Portuguese Republic. From then on, it has been at the forefront of health protection for all Portuguese citizens, in an universal and general way [11], irrespective of one's socioeconomic, employment or legal status. The Ministry of Health, as the coordinating body, is responsible for planning, organizing, regulating and managing the healthcare systems.

Financially speaking, it follows the Beveridge model, and the public hospitals are mainly funded through taxation. Part of the financing is also done by: (a) private voluntary insurances (PVI), (b) occupational-based health insurance schemes (the so-called public or private "health subsystems"), and (c) the citizen himself, by means of co-payments due to the provision of exams performed by private providers and the acquisition of pharmaceutical products.

Primary healthcare has become the principal undertaking of the NHS. It is centered on the patients and their families, and the communities to which they belong. It consists of activities for health promotion, disease prevention, follow-up and treatment of less severe conditions, respecting the physical, psychological, social and cultural dimensions [11]. Secondary care is provided by public hospitals and consists of hospitalization, specialty medical appointments, complementary diagnostic and therapeutic exams, and emergency room department. For several years, primary and secondary healthcare have been poorly articulated within the NHS. With the goal of facilitating the link between these levels, a vertical integration has been introduced by the creation of Local Health Units (LHUs), in 1999. The main goal was to improve the health system's response, through and integrated provision of all levels of care, namely long-term care [12].

To sum up, Portugal has a strong record on developing coherent and well-focused health plans, to ensure better access, quality and efficiency of care, which are essential to guarantee the NHS sustainability. However, the impact of social determinants is not equitable and health inequalities remain one of the key challenges for the NHS.

2.2. Patient satisfaction

Over the past decades, given the customer-orientation philosophy and continuous improvement principles of modern enterprises, consumer satisfaction has gained widespread recognition as a measure for quality in many public sector services, particularly in the healthcare sector. Even so, the conceptual basis of satisfaction with healthcare is not entirely established, which makes its measurement a complex task.

If one looks in a dictionary for the definition of the word "satisfaction", one will find that it comes from the Latin, meaning "enough" and the fulfilment of one's wishes, expectations, or needs, or the pleasure derived from this, leaving no room for complaint [1]. In fact, although different approaches to define satisfaction may be found in the literature, the most popular is based on the fulfilment of customer expectations [9].

Although the abovementioned definition seems quite simple and adequate, in reality, it assumes a rather complex and abstract nature, especially as

far as healthcare is concerned. First of all, satisfaction itself does not imply a superior service, *i.e.*, it can be achieved by an adequate or acceptable standard of service. Secondly, if different individuals are asked to evaluate a service, they usually compare their personal subjective standards with their own perception of care received [5], meaning that the concept of satisfaction assumes a highly subjective, rather than an objective, nature.

In the light of overcoming the existing lack of clarity regarding satisfaction's definition and measurement, it is worthwhile to consider the highly cited Donabedian's framework on how to examine health services and evaluate quality of medical care [6]. According to the latter, quality may play a pivotal role on patients' satisfaction, which in turn is a necessary, but not a sufficient, condition for effective care. Furthermore, the key to assess the quality of care lies in a mix of three clinical and patient-centered indicators: (1) structure of care, (2) process of care and (3) outcomes. Throughout his work, Donabedian regarded the latter as the most important aspect. In fact, although patients' satisfaction is a direct effect of care, *i.e.*, an outcome itself, it cannot be correctly measured without accounting for the other two indicators.

Similarly to what happens in other sectors, there is an inherent value to patient-centered care and to the continuous creation of patient satisfaction. Besides, empirical evidence shows that satisfied patients produce better outcomes, as they are often more likely to follow medical advice after discharge [4]. In addition to the fact that satisfaction is a goal in itself, curiously its measurement ends up motivating the healthcare providers as well, who are involved throughout the process of care delivery. Indeed, if all the improvement efforts are evaluated by the customers themselves [9], the service providers naturally become more inspired and focused to perform and achieve higher levels of productivity.

At the end of the day, it all comes down to this: if the goal is to create the best healthcare services, managers must be able to assess the quality of provided care. This can only be done by monitoring direct feedback from patients about their perceptions of the quality of care they received. To achieve that, patients must be asked to self-complete a simple questionnaire. With the obtained results, healthcare providers and policy makers must be able to understand patients' needs and identify service factors that need improvement, making room for the delivery of effective and better quality services to the end users, *i.e.*, the patients themselves [3].

2.3. The MUSA method

With the goal of analysing in detail patient satisfaction, as well as identifying priorities to improve provider's performance and patients' experience, this study has employed the MUSA method, initially proposed by Grigoroudis and Siskos [8]. Fundamentally, the major advantage of this method is that it fully considers the qualitative form of patients' judgements and preferences, as they are expressed in the satisfaction surveys. The main ambition of this very useful linear programming model is the aggregation of independent (unrelated) individual judgements into a collective, monotone, non-decreasing, and positive value function, assuming that a patient's global satisfaction depends on a set of n criteria that represent service characteristic dimensions.

The next sections entail the main concepts and definitions underlying the MUSA method.

2.3.1. *Concepts, definitions and notation*

Consider the following notation [7]:

- $G = (g_1, ..., g_j, ..., g_n)$ represents a set of family criteria;
- g_j, with $j = 1, ..., n$, is the j^{th} criterion of set G (n denotes the number of criteria);
- E_j is the discrete scale of criterion g_j, ($j = 1, ..., n$);
- g_j^l, with $j = 1, ..., n$ and $l = 1, ..., L$, represents the l^{th} dis(satisfaction) level (hereinafter only considered satisfaction levels), *i.e.*, $E_j = \{g_j^1, ..., g_j^l, ..., g_j^{Lj}\}$;
- $g_j^1 \precsim ... \precsim g_j^l \precsim ... \precsim g_j^{Lj}$ denotes a total order for g_j^l; symbols $\prec$ and $\backsim$ mean "strictly less preferred than" and "as preferable as", respectively; *e.g.*, the totally satisfied level ($l = L_j$) is strictly more preferred than the totally dissatisfied level ($l = 1$);
- $E = \{g^1, .., g^l, .., g^L\}$ is a discrete scale associated with the overall satisfaction; as before, $g^1 \precsim ... \precsim g^l \precsim ... \precsim g^L$denotes a total order for g^l, $l = 1, ...L$;
- $P = \{1, ..., q, ..., p\}$ denotes a set of patients whose satisfaction regarding a hospital (or set of hospitals) is being assessed; each patient $q \in \{1, ..., p\}$, will characterize the hospital according to a single level of each scale E_j, for $j = 1, ..., n$ and E.
- $x_j^{(q)} \in E_j$ represents the satisfaction level assigned by patient q with respect to the j^{th} criterion, g_j;
- $x^{(q)} \in E$ denotes the overall satisfaction level assigned by patient q with respect to the whole hospital (or set of hospitals);
- $\hat{x}^{(q)} \in E$ denotes the overall satisfaction level;
- $v(x^{(q)}) : E \longmapsto [0, 1]$ is a monotone non-decreasing value function of its argument $x^{(q)} \in E$; $v(x^{(q)})$ is the value function associated with each overall satisfaction score, and

$v(g^1) = 0 \leqslant ... \leqslant v(g^l) \leqslant ... \leqslant v(g^L) = 1$;

- $v_j(x_j^{(q)}) : E_j \longmapsto [0,1]$ is a monotone non-decreasing value function associated with the partial satisfaction score j, with $v_j(g_j^1) = 0 \leqslant ... \leqslant v_j(g_j^l) \leqslant ... \leqslant v_j(g_j^L) = 1$;
- $\alpha^{(q)}$ is a free error variable associated with patient $q \in \{1, ..., p\}$; it can be decomposed into two non-negative error variables, $\alpha^{(q)+}$ (overestimation error) and $\alpha^{(q)-}$ (underestimation error), such that $\alpha^{(q)} = \alpha^{(q)-} - \alpha^{(q)+}$.

The level assigned by patient q to characterize the overall satisfaction of the hospital is given by $x^{(q)} \in E$, thus the value of $\hat{x}^{(q)}$ is denoted by $v(\hat{x}^{(q)})$. If an additive model can be employed with the partial values' aggregating purposes, the following is true

$$v(x^{(q)}) = \sum_{j=1}^{n} v_j(x_j^{(q)}) \tag{1}$$

where $x_j^{(q)} \in E_j$ is the level of satisfaction selected by patient q to characterize the hospital according to the criterion g_j. Following the robust ordinal regression methodology, this method assumes that the overall satisfaction should be the same as the aggregating results, *i.e.*, $\hat{x}^{(q)} \sim x^{(q)}$, which implies:

$$v(\hat{x}^{(q)}) = v(x^{(q)}) \tag{2}$$

However, very often there are some errors present. Therefore, the free error variable, which can be divided into two non-negative variables, $\alpha^{(q)+}$ and $\alpha^{(q)-}$, is introduced in Eq. 2, as follows:

$$v(\hat{x}^{(q)}) = \sum_{j=1}^{n} v_j(x_j^{(q)}) - \alpha^{(q)+} + \alpha^{(q)-} \tag{3}$$

2.3.2. *Standard MUSA*

The objective function can be defined as the minimization of the sum of the non-negative error variables, for all patients. In addition, the value of the objective function reflects the amount of inconsistencies in the model, *i.e.*, when it is equal to zero, all the information provided by the patients, both globally and partially, is consistent, otherwise it is biased for some reason.

$$\text{minimize } z = \sum_{q=1}^{p} (\alpha^{(q)+} + \alpha^{(q)-}) \tag{4}$$

subject to:

$$\begin{aligned} & v(g^L) - v(x^{(q)}) = \left(\sum_{j=1}^{n} v_j(g_j^{L_j}) - v_j(x_j^{(q)}) \right) + \\ & \alpha^{(q)+} - \alpha^{(q)-} \leftrightarrow \\ & v(x^{(q)}) = \sum_{j=1}^{n} v_j(x_j^{(q)}) - \alpha^{(q)+} + \alpha^{(q)-} \\ & q = 1, ..., p \end{aligned} \tag{5}$$

Eq. 5 models the indifference relation between the overall satisfaction and the conjoint aggregation of the partial satisfactions. The gap between the values of the highest satisfaction level and the overall q^{th} judgement must be equal to the gap between aggregating results, plus an error term [7].

$$v(g^l) - v(g^{l-1}) \geqslant 0 \ , \ l = 2, ..., L \tag{6}$$

$$\begin{aligned} & v_j(g_j^l) - v_j(g_j^{l-1}) \geqslant 0, \ j = 1, ..., n \text{ and} \\ & l = 2, ..., L_j \end{aligned} \tag{7}$$

The last two constraints imply that the corresponding value functions are non-decreasing monotone.

$$v(g^L) = 1 \tag{8}$$

$$v(g^1) = 0 \tag{9}$$

By imposing the constraint 8, one states that the value of the best performance is unitary, *i.e.*, no satisfaction level is preferable to the highest one. Similarly, constraint 9 declares that the value of the worst satisfaction level is null, and that there is no worse satisfaction level that the lowest one, $l = 1$. Thus, one can easily assert that the overall satisfaction value is bounded within the range $[0, 1]$.

$$\sum_{j=1}^{n} v_j(g_j^{L_j}) = 1 \tag{10}$$

The latter constraint means that the cumulative value of the best performance in all criteria equals the best performance's value in overall judgements.

$$v_j(g_j^1) = 0 \ , \ j = 1, ..., n \tag{11}$$

$$v(g^l) \geqslant 0 \ , \ l = 2, ..., L - 1 \tag{12}$$

$$v_j(g_j^l) \geqslant 0 \ , \ j = 1, ..., n \text{ and } l = 2, ..., L_j \tag{13}$$

$$\alpha^{(q)+}, \alpha^{(q)-} \geqslant 0 \ , \ q = 1, ..., p \tag{14}$$

Constraint 11 is similar to 9, as it states that the partial value of the worst performance in each subcriterion is zero. Likewise, the cumulative value of the lowest satisfaction level in all subcriteria must be null. The last three constraints establish the non-negativity of the variables to be optimized.

3. Implementation

Throughout this section, the case study is detailed, followed by an introduction to the Kano's model, and finally, the computation of the satisfaction, demanding and improvement indexes is described, along with the construction of the action/improvement diagrams.

3.1. Case study

An already existing database was provided by the Amato Lusitano (AL) hospital, which makes part of the Local Health Unit of Castelo Branco (LHUCB), located in the central region of Portugal. The process of data gathering was done through the conduction of a satisfaction survey, targeting patients that were experiencing, or have experienced, the inpatient service in this hospital. The resulting database was provided in an Excel file, with the relative frequency of patients assessing their own global and partial satisfactions with regard to a set of chosen criteria/subcriteria that characterize the considered service. More specifically, each respondent was asked to select one and only one rate when answering to the following questions:

1. On an ordinal scale (from 1 to 7), where 1 denotes *very dissatisfied* and 7 denotes *very satisfied*, how satisfied are you with regard to [a specific criterion/subcriterion]?
2. On an ordinal scale (from 1 to 7), where 1 denotes *very dissatisfied* and 7 denotes *very satisfied*, how satisfied are you with regard to the inpatient service as a whole?

Throughout this study, it is assumed that a patient's global satisfaction with the inpatient service depends on eleven main criteria (each of them characterized by a set of subcriteria): (g_1) received information, (g_2) facilities' quality, (g_3) visits, (g_4) food quality, (g_5) medical staff, (g_6) nursing staff, (g_7) auxiliary staff, (g_8) administrative staff, (g_9) volunteering staff, (g_{10}) exams and treatments, and finally, (g_{11}) discharge process.

The questionnaire comprised a total of 65 questions, and it was answered by 251 subjects. In order to generate *bona fide* information, and to be able to draw useful conclusions, the data was then treated. This led to a reduction of the number of answers analyzed for each criterion. Nevertheless, this step was important to obtain more reliable data, bearing in mind that merely redundancies were eliminated.

3.2. Kano's model

It has been found that not all customer requirements have the same ability to deliver high satisfaction when done well. It may occur that some satisfaction dimensions are taken for granted by patients, in which case, if not entirely fulfilled, patients generally become deeply dissatisfied, however they express no signs of satisfaction otherwise.

To tackle this complex scenario, the so-called Kano's model was created, and later refined [14] to incorporate additional information. This model is based on the assumption that the features of a specific product/service are multidimensional, affecting the level of customer satisfaction to varying degrees. Accordingly, customer preferences can be classified into five different categories:

1. *Must-be requirements*, are the basic attributes (*i.e.*, the prerequisites). These are very often taken for granted, thus if not entirely fulfilled, customers become very dissatisfied, although neutral otherwise.

2. *One-dimensional (or desired) qualities*, customer satisfaction is proportional to the level of fulfilment. These are usually explicitly demanded by customers.

3. *Attractive requirements*, these are neither explicitly expressed nor expected by the customer - pleasant surprises or delights. These cause satisfaction if present but do now cause dissatisfaction if absent.

4. *Indifference requirements*, satisfaction remains neutral as these add no further value to customers' experience.

5. *Reverse quality attributes*, features that cause customer dissatisfaction when present, and satisfaction when absent.

A linking was done between the MUSA method and the Kano's model, in order to identify which quality attributes influence customer satisfaction the most, and which are rather indifferent. To do so, patients were divided into two distinct groups: those globally *satisfied* (whose overall satisfaction score was above the neutral 4^{th} level) and those globally *dissatisfied*. By applying the MUSA method twice, one can then compute and compare the corresponding weights associated to the dissatisfied patients, w^d_{jk}, and to the satisfied ones, w^s_{jk}. In short, (a) if the former is higher than the latter, then the corresponding attribute is a must-be requirement; (b) the opposite situation is true for attractive requirements; (c) if $w^d_{jk} \approx w^s_{jk}$, that corresponds to an one-dimensional requirement [7].

3.3. Satisfaction, demanding and improvement indexes

Evidence suggests that patients tend to indicate that they are generally satisfied [10] and that overall satisfaction often provides an overoptimistic evaluation of patients' experiences with healthcare. Nevertheless, the levels of patient satisfaction are highly relevant quality indicators, as they reflect the consumers' perceptions and the success of providers at meeting their values and expectations.

From the results obtained with MUSA, one can compute the average satisfaction indexes with regard to each criterion/subcriterion, as follows:

$$S_j = \sum_{l=2}^{L_j} P_{lg_j} \cdot v_j(g_j^l) \tag{15}$$

where the first term of the sum consists of the frequency of customers rating the j^{th} criterion with the satisfaction level l.

Furthermore, patients can be more or less demanding with regard to a particular criterion/subcriterion, which translates into different shapes of the utility functions. Three distinct groups can be identified: (1) a linear utility function is characteristic of neutral customers, (2) demanding customers are associated with convex utility functions and (3) a concave shape represents the non-demanding customers. Despite its usefulness, taking conclusions based exclusively on the curves' representation can be rather dubious.

Alternatively, the estimation of an index for studying patients' demanding nature may offer more trustworthy results. Basically, demand corresponds to the average deviation of the estimated utility curves from a "normal" (*i.e.*, linear) function. Let D_j be the demanding index, for $j \in \{1, ..., n\}$ (adapted from Ferreira, D. C., Marques, R. C., Pedro, M. I., 2019, *Luxury 5-star hotels in five European capital cities: How to improve customer satisfaction?*, Elsevier Editorial System for Tourism Management.):

$$D_j = 1 - \frac{1}{v_j(g_j^{L_j}) \cdot g_j^{L_j}} \cdot \sum_{l=2}^{L_j} \left(v_j(g_j^l) + v_j(g_j^{l-1}) \right) \tag{16}$$

For neutral patients, one gets $D_j = 0$. Positive values of D_j identify demanding patients. Contrarily, negative values of D_j correspond to non-demanding patients. Demanding indexes are defined in the interval $[-1, +1]$

In addition, if one wants to enhance the patients' experience with a certain service, it is rather logical to first ascertain whether there is room for improvement or not, and if so, in which dimensions that could be beneficial. The latter depends on (1) the importance of the particular satisfaction dimension (*i.e.*, its weight), and (2) its contribution to patients' dissatisfaction. Potential improvement indexes, Δ_j and Δ_{jk}, for all $j = 1, ..., n$ and $k = 1, ..., n_j$, are normalized in the interval [0,1], and can be computed as follows:

$$\begin{cases} \Delta_j = v_j(g_j^{L_j}) \cdot \left(1 - \sum_{l=2}^{L_j} P_{lg_j} \cdot v_j(g_j^l) \right) \\ \Delta_{jk} = v_{jk}(g_{jk}^{L_{k_j}}) \cdot \left(1 - \sum_{l=2}^{L_{k_j}} P_{lg_{jk}} \cdot v_{jk}(g_{jk}^{l_{k_j}}) \right) \end{cases} \tag{17}$$

3.4. Action and improvement diagrams

Patients' demanding nature has a direct impact on priorities. By combining these results with the average improvement indexes, strategic priorities can be traced, by the construction of improvement diagrams.

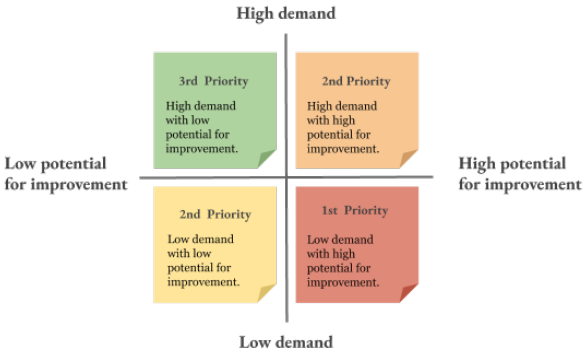

Figure 1: Improvement diagram with strategic priorities.

These diagrams are divided into four quadrants, as shown in Figure 1, according to demanding (high/low) and margin for improvement (high/low) [8].

Similarly, action diagrams can also be constructed. These diagrams are developed based on the combination of criteria/subcriteria average satisfaction indexes and weights [8]. They reflect opportunities for resources allocation and define the required improvement efforts, indicating the strong and weak points of customer satisfaction. As represented in Figure 2, these maps are also divided into four quadrants, this time according to performance (high/low) and importance (high/low):

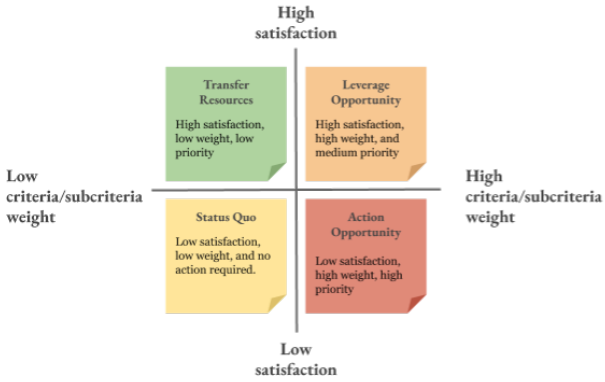

Figure 2: Opportunities' diagram.

4. Results

MUSA method departs from the assumption that a patient makes a series of independent judgements on a number of unrelated criteria, considering that there are no interaction effects. Then, the model constructs monotone non-decreasing positive utility functions, for each criterion. From those, the relative importance (weight) of each criterion/subcriterion can be assessed, indicating which service features are more likely to influence customer satisfaction. The latter provides a basis for interpreting the main results obtained through MUSA, which are presented on Table 1.

The only criterion that stands out in terms of importance is the 'Auxiliary staff'. Auxiliaries establish a close relationship with hospitalized patients, as they usually are the most accessible contact patients get. In fact, except for the drugs administration, this team is responsible for the patients' hygiene, the food distribution, and for any particular situation for which patients ask for information, help or comfort. Accordingly, this criterion's extreme importance would be expected (weighing 70%), specially in terms of the auxiliaries' 'readiness and availability' (91%). In terms of overall performance, this criterion was the one with which patients have shown the highest satisfaction score (68.70%). In addition, the 'Auxiliary staff' has presented the largest room for improvement of 21.91%.

With regard to the demanding levels of the respondents, one can observe on Table 1 that, for the majority of the cases, patients have manifested a non-demanding nature. If one considers that neutral demanding indexes are within the interval [-0,05 - 0,05], then criteria with which patients are demanding are scarce: 'attention', 'sympathy and kindness' of the 'Auxiliary' and 'Administrative staff', and the latter's 'actions' efficiency'. Patients have shown to be non-demanding for most of the inpatient service attributes, in particular for 'Facilities' quality', 'Visits' and 'Discharge process'.

According to the Kano's model, the majority of the subcriteria has shown to be one-dimensional requirements. For those service features, the level of satisfaction is proportional to the level of fulfilment, which means that the greater the fulfilment of these desired qualities, the higher is the customer satisfaction, and *vice-versa*. Some attractive requirements were identified as well, namely the 'substitution in decision making', the facilities' 'privacy', the 'information on patients' clinical status', the 'information on nursing treatments', the 'readiness and availability' of the auxiliaries, and the 'waiting time to leave' after discharge. Regarding those, satisfied patients assigned a much larger weight than dissatisfied ones. Lastly, and most importantly, the identification of must-be requirements is crucial for the hospital's continuous improvement and enhancement of patients' satisfaction and experience. In line with this, the attributes which patients take for granted are the 'ways of complaints', the facilities' 'cleanliness and hygiene', the doctors' 'sympathy and kindness', the nurses' 'readiness and availability', the auxiliaries' 'actions' efficiency', the 'readiness and availability' of exams and treatments and finally the 'home-care provided information' after discharge.

4.1. Discussion

This study aimed at evaluating patients' satisfaction with regard to the Portuguese secondary healthcare provision, namely the inpatient service valence of AL hospital, included in the LHUCB. To do so, the MUSA method was carried out, and the obtained results included value functions, criteria weights, satisfaction, demanding and improvement indexes, and moreover they allowed the construction of action and improvement diagrams. However, one has to keep in mind that, given its empirical nature, MUSA is not entirely flawless, neither is the present study. The model assumptions and the quality of the collected data may bring potential implementation problems to the MUSA method. On the one hand, the chosen satisfaction criteria set may not be a consistent family of criteria and, on the other hand, it should not be forgotten that patients may not be rational decision-makers and might be unable to correctly and non-emotionally evaluate the quality of care, given the severity and/or complexity of their illness.

Unfortunately, the obtained results seem to be inconsistent with the reality. In fact, the utility functions provided by MUSA were the starting point of these inconsistencies. For some of the criteria, the value of the global satisfaction has been lower than the value of some partial satisfactions, which is odd and probably related with the provided data. Additionally, for the majority of the criteria, only one or two features stood out, while the others presented

almost null weights - a threshold of 3% was imposed on the model to avoid null weights.

That being said, one should expect that satisfaction, demanding and improvement indexes would also be affected. Starting with the average satisfaction index, S_j, Equation 15 makes it evident that, if $v_j(g_j^l)$ assumes almost insignificant values, then the satisfaction score becomes very low as well, which is exactly what is displayed on the forth column of Table 1. Regarding the demanding indexes, from Equation 16, it is possible to conclude that, the lower the criteria/subcriteria weight, the more negative would be the D_j. As expected, for the generality of the cases, a non-demanding nature was observed. Furthermore, the results show almost no room for improvement (note that neither the criteria nor the subcriteria centroids exceed 7% of potential improvement). After carefully analysing Equation 17, the latter becomes easily explained. In fact, considerable improvement indexes can be obtained if, and only if, the criteria/subcriteria weight deviates from zero, which is the case of the facilities' room temperature, for instance.

5. Conclusions

Notwithstanding the lack of consistency of the obtained results, one should not forget that these are purely outcomes from the mathematical structure underlying the MUSA method. In order to optimize the weights and value functions, this model tries to minimize the potential errors associated with patients' judgements. Additionally, the assumed independence between criteria may give rise to the Halo effect - the patients' assessment about one criterion may influence their opinion about another criterion. Therefore, and specially if the sample is not adequate, it is possible to acquire results with no practical meaning. Moreover, as a linear programming model, MUSA is sensitive to the number of constraints and variables: the higher the number of satisfaction levels, the higher the probability of failure.

It is reasonable to say that the goals set forth at the beginning of this study were not entirely met. The gathered and treated data sample is believed to constitute the main reason why the present study was inconclusive. In fact, for some criteria, the analysed sample was not even statistically valid ($N < 30$). The satisfaction survey targeted patients that were hospitalized at AL hospital, during the year of 2018. Despite the fact that, during that same year, nearly 7750 patients were discharged from that interment service, the analysed sample comprised the answers of only 251 patients, which is relatively low, considering the hospital's total capacity of 225 beds [13]. The main prospective developments and future considerations can be epitomized in a few remarks.

It is understandable that, the higher the scale, the easier it is for the patients to assess their satisfaction with regard to a certain product/service. However, given MUSA's sensibility to the number of satisfaction levels, this also enhances the failure probability of the mathematical model. Future research shall thus compare these results with others obtained through less satisfaction levels.

In addition, if one aims to accurately measure the performance of the internment service, then a much larger data sample should be considered. That way, even after data processing, the sample remains statistically valid. In particular, with respect to the AL hospital, a sample comprising half the number of the discharge patients in one year (*i.e.*, around 3 870 patients) should be more adequate.

This last point accounts for the possible shortcomings of the widely used satisfaction surveys. The most criticized aspect must be their subjectivity. In fact, this surveys do not take into account the existence of different patient groups whose preference value systems may differ. The segmentation of the total set of patients into smaller groups according to particular characteristics (*e.g.* age, sex) must be the most reliable solution to tackle this problem. Finally, a possible alternative to the traditional surveys would be a smartphone application (with a QR code reader), that would allow patients to evaluate each step of their journey, instantaneously. This way, patients would judge the different aspects of the service, soon after they have experienced them. It is reasonable to imagine that this evaluation would be fresher and more trustful, and more consistent data would be collected.

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Table 1: MUSA main results regarding criteria and subcriteria weights.

Criteria	Subcriteria	w_j [%]	S_j [%]	D_j [-1,+1]	Δ_j [%]
$[g_1]$	User's guide	3,00	2,87	-0,2857	2,91
	User's rights and duties	42,50	40,68	-0,2857	25,21
	Ways of complaints	3,00	2,83	-0,2857	2,92
	Substitution in decision-making	48,50	46,42	-0,2857	25,99
	Anticipated vital will	3,00	2,83	-0,5714	2,92
	Global	*3,00*	*2,69*	*-0,2857*	*2,69*
$[g_2]$	Cleanliness and hygiene	3,00	2,92	0,0000	2,91
	Comfort and commodity	3,00	2,96	-0,2857	2,96
	Privacy	3,00	2,86	0,0000	2,91
	Furniture	42,50	40,84	0,0000	25,14
	Noise	3,00	2,86	-0,5714	2,91
	Room temperature	42,50	41,12	-0,2857	25,02
	Distractions	3,00	2,94	-0,5714	2,91
	Global	*3,00*	*2,92*	*-0,5714*	*2,91*
$[g_3]$	Schedule	3,00	2,94	-0,5714	2,91
	Visit duration	3,00	2,94	-0,5714	2,91
	Number of visits	91,00	90,17	-0,5714	8,95
	Facilities for close relatives	3,00	2,97	-0,5714	2,91
	Global	*3,00*	*2,94*	*-0,5714*	*2,91*
$[g_4]$	Preparation, appearance, temperature, taste	3,00	2,95	-0,2857	2,91
	Variety	91,00	89,39	-0,2857	9,66
	Quantity	3,00	2,95	-0,5714	2,91
	Meal support	3,00	2,92	-0,5714	2,91
	Global	*3,00*	*2,89*	*-0,2857*	*2,91*
$[g_5]$	Readiness and availability	3,00	2,96	-0,2857	2,91
	Attention	3,00	2,96	-0,2857	2,91
	Sympathy and kindness	3,00	3,00	-0,2857	2,91
	Information on the patient's clinical status	82,00	78,89	-0,5714	17,31
	Information on the medical treatments	3,00	2,96	-0,5714	2,91
	Information on the exams	3,00	2,89	-0,2857	2,91
	Health advising and teaching	3,00	2,89	-0,2857	2,91
	Global	*3,00*	*2,86*	*-0,2857*	*2,91*
$[g_6]$	Readiness and availability	3,00	2,94	-0,2857	2,91
	Attention	3,00	2,88	0,0000	2,91
	Sympathy and kindness	3,00	2,88	0,0000	2,91
	Information on the patient's clinical status	3,00	2,88	0,0000	2,91
	Information on the nursing treatments	85,00	81,53	-0,2857	15,70
	Health advising and teaching	3,00	2,88	-0,2857	2,91
	Global	*3,00*	*2,92*	*0,0000*	*2.91*
$[g_7]$	Readiness and availability	91,00	87,75	-0,2857	11,15
	Attention	3,00	2,68	0,2857	2,92
	Sympathy and kindness	3,00	2,46	0,5714	2,93
	Action's efficiency	3,00	2,89	-0,2857	2,91
	Global	*70,00*	*68,70*	*-0,2857*	*21,91*
$[g_8]$	Readiness and availability	3,00	3,00	-0,2857	2,91
	Attention	3,00	1,83	0,5714	2,95
	Sympathy and kindness	91,00	75,17	0,2857	22,59
	Action's efficiency	3,00	1,83	0,5714	2,95
	Global	*3,00*	*2,86*	*-0,2857*	*2,91*
$[g_9]$	Readiness and availability	3,00	3,00	-0,2857	2,91
	Attention	94,00	94,00	-0,2857	5,64
	Sympathy and kindness	3,00	3,00	-0,2857	2,91
	Global	*3,00*	*2,03*	*-0,2857*	*2,94*
$[g_{10}]$	Readiness and availability	3,00	2,84	-0,2857	2,91
	Professionals' attention	3,00	2,88	-0,2857	2,91
	Sympathy and kindness	3,00	2,88	-0,2857	2,91
	Information on the patient's clinical status	3,00	2,84	-0,2857	2,91
	Information on the medical treatments	3,00	2,84	-0,2857	2,91
	Information on the exams	3,00	2,84	-0,5714	2,91
	Health advising and teaching	82,00	77,57	-0,5714	18,39
	Global	*3,00*	*2,83*	*0,0000*	*2,92*
$[g_{11}]$	Home-care provided information	97,00	94,82	-0,2857	5,03
	Waiting time to leave (after discharge)	3,00	2,92	-0,2857	2,91
	Global	*3,00*	*2,75*	*-0,5714*	*2,92*
Centroids	Criteria	9,09	8,76	-0,3117	4,64
	Subcriteria	3,00	2,94	-0,2857	6,27

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