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## Emergency Service of the University Hospital of Algarve in Faro:

### A Contribution of the DISTATIS Method to Classify and Prioritize its Main Issues and Challenges

#### Abstract

Events occurring in hospital emergency services tend to be of a chaotic and complex nature, giving rise to unique challenges, mainly in the fields of finance management, equipment, workloads and human resources. The research here presented addresses the issue, first by determining the top ten problems and challenges facing the Emergency Service of the University Hospital of Algarve in Faro and second by underlining perceptions and associated levels of importance attributed by an in-house group of specialists that assist on the unit's management process. Data was collected in two phases a) a brainstorming exercise with work-shift leaders for generation of opinions and ideas regarding the evaluation of the top ten problems; b) presentation of the top ten issues to a panel of experts who, on an individual basis, classified, categorized and ranked them. Collected data was of a multidimensional nature and it was later analysed using an innovative three-way technique, the DISTATIS method (Abdi et al., 2005; Abdi et al., 2007). In our evaluation of the expert responses, we highlighted experts whose options were characterized by similarities and differences and others with stable and unstable opinions. Final results provided information on opposition and coherence among the experts, identifying common themes and problems relevant to the organization's management and decision processes.

#### Keywords

DISTATIS; Sorting Task; Health Management; Emergency Services.

## 1. Introduction

The activities developed in the emergency services take place in unique, complex, dynamic environments that are sometimes almost chaotic and thus tend to be stressful and exhausting for health professionals (Seow, 2013; Çıkırlar et al., 2015; Brazão et al., 2016; Naccarella et al., 2018; Truta et al., 2018). This is mainly due to five management issues related to: a) predicting and planning difficulties; b) budget issues; c) issues with equipment management; d) difficulties in human resource management; and e) obstacles to optimizing space, usually undersized for the population using the services and their needs.

Demand for these services affects quality as the high number of people demanding the services exceeds their capacity. In fact, overcrowding is a worldwide issue which, besides hindering care in terms of safety, quality and efficiency, is closely linked with decrease in user satisfaction (Tekwani et al., 2013; Leung et al., 2017; Hu et al., 2018; Truta et al., 2018; Yoo et al., 2018).

In Portugal, according to DGS (2015), OECD (2017) and Abrantes & Simões (2018), one of the major challenges of the National Health Service (NHS)

has to do with managing: a) population aging; b) morbidity factors linked to aging; and c) technological development and innovation that may lead to the system experiencing financial and economic difficulties. According to Tavares et al. (2017), "...due to an aging population and difficulties in staff retention, the health system may face financial and human resource sustainability problems". In truth, Portugal is the country with the fifth oldest population in the world. An aging population leads to an increase in chronic diseases. And this, according to Brazão et al. (2016), appears to be related to a growing demand for emergency services and hospital stays, justified by: a) the increase in chronic diseases; b) multimедication and c) the population's social and economic situations.

These issues cause dysfunction in the emergency services, among which Machado et al. (2018) emphasizes as the most important: a) the increase in waiting time for a doctor's appointment; b) delays in starting drug therapy or treatment; and c) delays in transferring from emergency services to an inpatient bed, increased risk of infection associated with healthcare, leading to an increase in the number of days of hospital stay and associated costs. In effect, patients' time of stay in the emergency services may increase the risk of adverse events by about 3% per hour (Batista et al., 2017). Sousa et al. (2014) state that 3.4% to 16.6% of users resorting to the emergency services in Portugal have experienced an event that should not have happened. About 59.2% of those users are 65 years old or over and we are led to believe that the older the patient, the higher the chance of these events taking place. In terms of unforeseen situations, Brazão et al. (2016) highlight the fact that the excess in demand for emergency services and overstay of patients in it cause issues in the availability of computer and medical equipment and in clinical material.

The University Hospital of Algarve (Centro Hospitalar Universitário do Algarve CHUA) offers services to the population in Algarve and is also a reference in Baixo (southern) Alentejo (CHA, 2016; CHUA, 2017). The general emergency services of the Faro Hospital is, in fact, the emergency services with the widest differentiation (in emergency response) in the region in terms of physical, human and technical resources (CRRNEU, 2012; CHUA, 2017).

Generally, hospital emergencies have always presented common operational inefficiencies across the world. There are specific and locally grounded issues, such as oversized infrastructures, long waiting time, patients with long hospital stays, patients admitted to the hospital in the emergency services for lack of hospital beds in the services, excessive referencing, work overload, multitasking, professional stress and burnout, lack of material, equipment or supplies, etc.

This research is based on a brainstorming exercise among medical and nursing professionals in charge of emergency service or shifts regarding the top ten issues or challenges which this particular emergency services service has. These issues were later presented to a panel of experts, selected considering their position in the emergency services and the fact that their operational areas and decisions might influence the dynamics of the emergency services. Using Sorting Tasks (Chollet et al., 2011; Varela & Ares, 2014; Vidal et al., 2014; Blanchard et al., 2017; Clicerí et al., 2017; Morrison et al., 2017), these experts, grouped, categorized, classified and ranked these top ten issues and/or challenges according to their perception. Finally, these perceptions were submitted to the DISTATIS procedure (Abdi et al., 2005; Abdi et al., 2007; Abdi et al., 2012; Gómez-Corona et al., 2017).

Therefore, this research aims to demonstrate that the interpretation of the perceptions and levels of importance selected by an in-house and institutional panel of experts may clarify the management process of the emergency services of University Hospital of Algarve in Faro. This interpretation will also provide useful information that may allow for and foster the implementation of future strategies.

## 2. Data and Methodology

The choice of the issues/challenges which the Faro general emergency services faces was made using brainstorming by experienced professionals with managerial positions in the emergency services, so that both a top ten issues/challenges could be established but also the operational areas with which they are associated and which affect the emergency services at management level could be identified.

This brainstorming included several work-shift leaders (nurses and doctors) in groups of 3 or 4. In total, the professionals that participated were: 10 male doctors, 8 female doctors, 9 male nurses and 7 female nurses, with ages between 42 and 54 and 15 to 27 years of experience in the emergency services.

The following top ten issues and/or challenges were listed: a) inadequate space; b) professional stress and burnout; c) lack of security; d) over referencing by basic emergency services; e) inpatients managed in the emergency service; f) patients' stay in the ER for 12 and often 24 hours; g) limited number of computers available to professionals; h) lack of material and supplies; i) communication issues; and j) professionals forced to multitask.

The experts who participated in this research were selected considering four criteria: a) the area of intervention; b) professional experience in the field and in the position; c) whether the function and the position were managerial or not; and d) the responsibility/authority of the position held, a decisive criterion for planning and designing future intervention strategies. A panel of ten experts was formed who worked in the University Hospital of Algarve in Faro and were highly influential in the emergency services (nursing, management, operations, logistics, computing, medicine, financial, administration, structures and pharmacy). This panel included 5 women with, on average, 22 years of professional experience in health and who had, on average, 5 years' experience in management, and 5 men with, on average, 26 years of professional experience in health and who had, on average, 17 years' experience in management.

The information regarding this group was collected using sorting tasks, a simple method with a high application potential. It encompasses a natural cognitive process to collect similar and related answers that do not require a quantitative answer. Data from everyday life that represent objects, concepts and products or services with common features are grouped to collect relevant information with a minimum intellectual effort (Chollet et al., 2011; Hopfer & Heymann, 2014; Varela & Ares, 2014; Vidal et al., 2014; Blanchard et al., 2017; Clicerri et al., 2017; Honoré-Chedozeau et al., 2017; Morrison et al., 2017).

The panel of experts was asked to conduct two tasks:

- 1) A sorting task in which the experts assessed the emergency services top ten issues/challenges according to the level of importance they assigned to them. The 10 stimuli (presented on cards) were randomly placed on a table and ranked according to level of importance (from the most to the least important);
- 2) A sorting task in which the experts assessed the top ten emergency services issues/challenges according to their perceptions. The 10 stimuli were randomly placed on a table and grouped according to the perceived level of similarity.

The responses obtained through the sorting tasks were subjected to DISTATIS (Abdi et al., 2005; Abdi et al., 2007; Abdi et al., 2012; Beaton et al., 2014; Schwarz et al., 2015; Gómez-Corona et al., 2017). This is sophisticated and highly versatile three-way methodology to analyse the relations between a structure of data matrices. This is an exploratory data analysis method adequate for distance matrix computed data using multidimensional scaling (MDS, Togerson, 1958), which can be used in a variety of situations applied to sorting tasks. The method first assesses the similarity between distance matrices and afterwards uses the STATIS method (Structuration des Tableaux à Trois Indices de la Statistique) by Escoufier (1973), L'Hermier des Plantes (1976), Lavit (1988) and Lavit et al. (1994) and multiple factor analysis (MFA) by Escofier & Pagès (1985), to detect a common structure in several data tables for a period of time or in several experimental situations in order to identify the differences and the similarities throughout those occasions. STATIS has three stages: interstructure analysis, compromise analysis and intrastructure analysis, i.e.:

- I. Stage 1: Interstructure analysis consists of global comparison of the data tables so as to identify similarities and/or differences but without identifying the individuals and/or variables responsible;
- II. Stage 2: Interstructure factor representation allows assessment of the possibility of a compromise matrix, which, as the name indicates, is a matrix the structure of which is similar to that of the original series and representative of all the data tables;
- III. Stage 3: The definition of compromise, in turn, allows for the Euclidean representation of the "positions" of the several individuals. In other words, identifying the associations between the variables and the individuals allows for interpreting the "positions" of the individuals in the compromise space in regards to the similarities/differences among the original variables and eventually leads to identifying those responsible in the intrastructure analysis. Finally, the trajectories describing the behaviour of each individual or each variable are drawn based on the compromise space.

### 3. Results and Discussion

#### 3.1. Results

Following distance matrix computation using MDS and using the STATIS method, the results are:

##### 3.1.1. Interstructure analysis

Figure 1 shows two different realities associated with the opinions of the experts. Under the highest inertia axis (Axis 1), we can see stability in terms of opinions by 9 experts with a 68% interpretability and only 14% of information under Axis 2, an instability related with the opinion of only one expert.

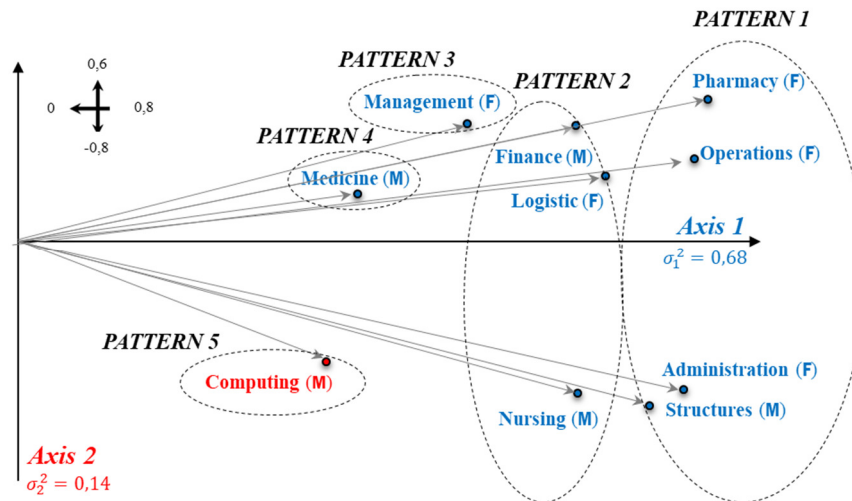


Figure 1. Euclidean representation of the interstructure (Adapted from outputs of Program R ADE4).

In Figure 1, 5 patterns can also be identified in the experts' statements.

- PATTERN 1: Under Axis 1 stability and high correlation in the opinions of 4 experts (Pharmacy, Operations, Administration and Infrastructures);
- PATTERN 2: Under Axis 1 stability and high correlation in the opinions of 3 experts (Finance, Logistics and Nursing);
- PATTERN 3: Under Axis 1 stability in the opinion of one expert (Management)
- PATTERN 4: Under Axis 1 stability in the opinion of one expert (Medicine)
- PATTERN 5: Under Axis 2, instability in the opinion of one expert (Computing)

##### 3.1.2. Compromise Analysis

Factor representation of the compromise matrix (Figure 2) allows assessment of the possibility of finding similarities between the issues/challenges listed in the emergency services, as occurred with the patterns detected in the experts' opinions. Therefore, under the highest inertia axis (Axis 1), with 44% interpretability, we find similarities in the experts' opinions when related to the 4 issues/challenges. Professionals forced to multitask (P5), Professional stress and burnout (P2), Communication issues (P7) and, on the opposite end, Lack of material and supplies (P6). Under Axis 2, with 34% interpretability, 6 issues/challenges are evidenced: Lack of security (P9), Inpatients managed in the emergency services (P10), Over referencing by basic emergency service (P3), Patients' stay in the emergency services for 12 and often 24 hours (P8) and, at the opposite end, Inadequate space (P4) and Limited number of computers available to professionals (P1).

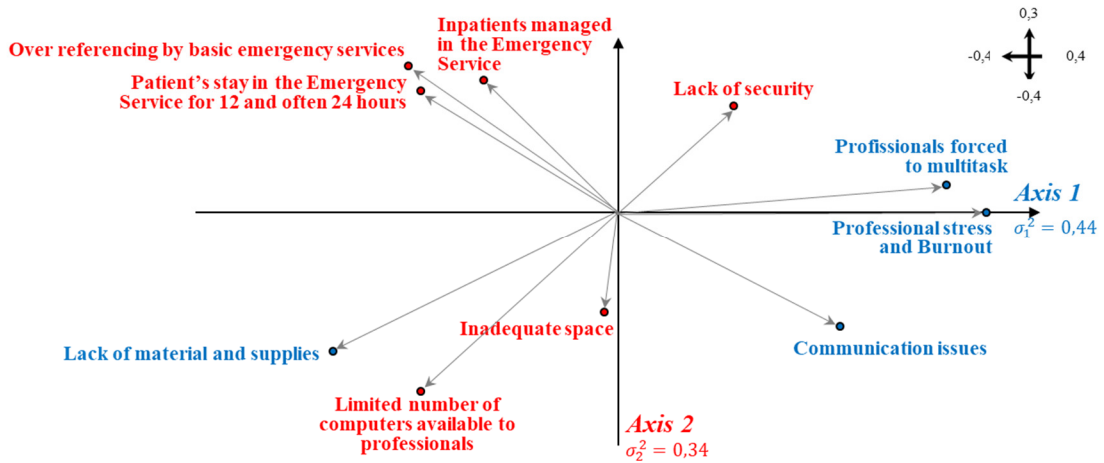


Figure 2. Euclidean representation of the compromise (Adapted from outputs of Program R ADE4).

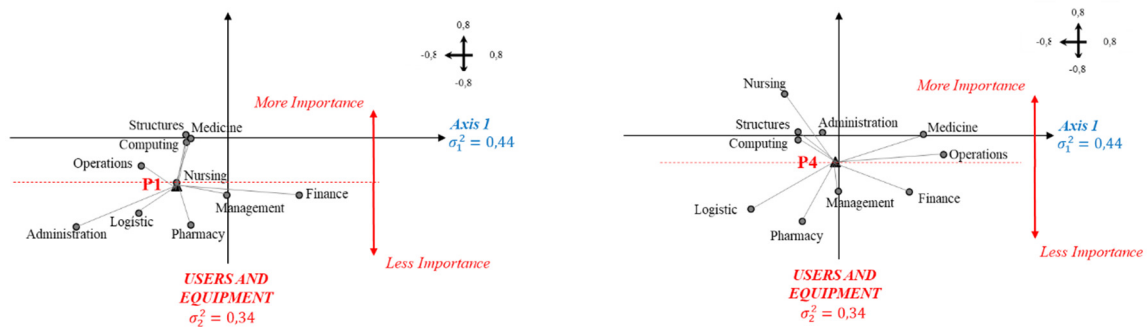
In regards to Axis 1, we can see that most of the issues/challenges considered most important are to the right of the centre of the Euclidean representation (1st and 4th quadrants). On the left (2nd and 3rd quadrants), we can find mostly those issues/challenges considered least important. Nevertheless, this set of issues/challenges characterizes Axis 1 as the opposition between the availability of means and materials and professional issues, which is why we opted for naming it HUMAN AND MATERIAL RESOURCES.

In regards to Axis 2, which we named USERS AND EQUIPMENT, we can see that the most relevant issues/challenges are in the top half above the centre of the Euclidean representation (1st and 2nd quadrants) and the least important issues/challenges are in the bottom half.

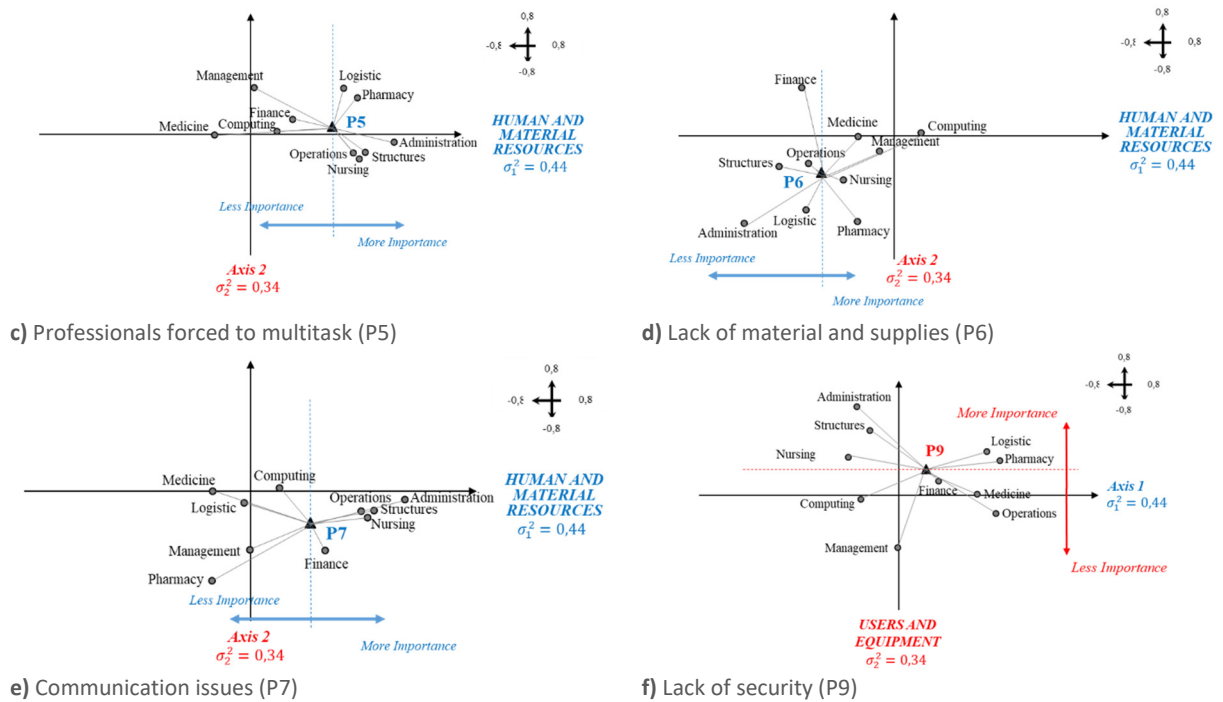
### 3.1.3. Intrastructure analysis

In the compromise area, the projection of the experts' opinions allows us to see the variability and the consistency of answers provided and characterize the issues/challenges in terms of agreement or disagreement with the opinions expressed by the experts.

In Figure 3, we can see the (widest) trajectories that describe the issues in which there is more disagreement in the opinions given by the professionals and less consistency, i.e., more disagreement in the opinions given by the experts.



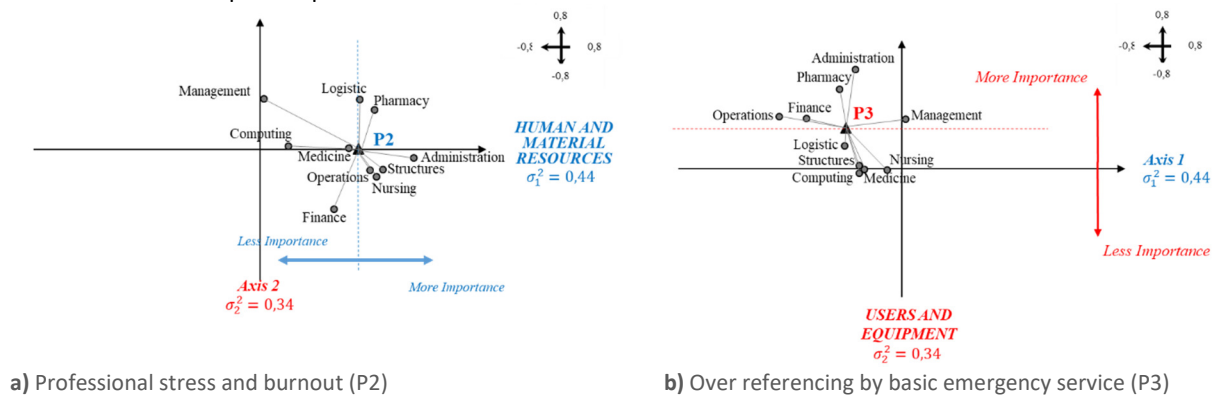
a) Limited number of computers available to professionals(P1)      b) Inadequate space (P4)

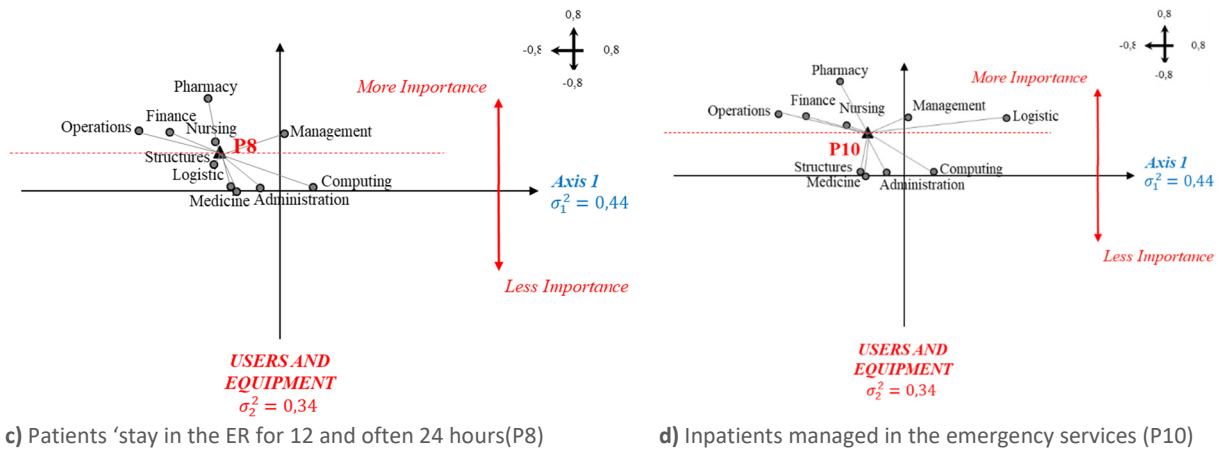


**Figure 3.** Euclidean representation of the intrastucture of the widest trajectories (Adapted from outputs of Program R ADE4).

For example, in relation to lack of material and supplies (P6), an issue associated with HUMAN AND MATERIAL RESOURCES, the expert in computing (who considered P6 more important) was the expert who contributed most to the positioning of this issue. The expert in operations (who considered this less important) was the least cooperative on this issue.

Similarly, Figure 4 shows the shorter trajectories that evidence the issues on which there was more agreement and on which the experts' opinions were more cohesive.





**Figure 4.** Euclidean representation of the intrastructure of the shortest trajectories (Adapted from outputs of Program R ADE4).

For example, in relation to professional stress and burnout, an issue associated with USERS AND EQUIPMENT, the expert in management (who considered P2 less important) was the expert who contributed most to the positioning of this issue. The expert in medicine (who also considered this less important) contributed least on this issue.

### 3.2 Discussion

Based on the intrastructure analysis, the experts' global perspectives are more similar in the 4 operational areas (pharmacy, operations, administration and infrastructures) and in 3 operational areas (logistics, nursing and finance). On the other hand, management, medicine and computing present specific perspectives on the issues studied.

It is evident that the 10 issues/challenges are accommodated in two groups: one, representing 44% of the information, links material resources (less important for the experts) and human resources (more important for the experts). The other, less prevalent, associates' users (more important for the experts) with service equipment (less important for the experts).

Therefore, and based on the information in Figure 5 on agreement/disagreement expressed by the experts, we were able to identify: a) less matching with the operational areas and b) more matching with the operational areas.

**Table 1.** Euclidean representation of the intrastructure of the widest trajectories.

Issue	Axis	Agreement	Greatest Influence	Minor Influence
Professionals forced to multitask (P5)	HUMAN AND MATERIAL RESOURCES	Lower	Medicine	Operations
Professional stress and Burnout (P2)		Greater	Management	Medicine
Communication issues (P7)		Lower	Pharmacy	Finance
Lack of material and supplies (P6)		Lower	Computing	Operations
Lack of security (P9)	USERS AND EQUIPMENT	Lower	Administration	Finance
Inpatients managed in the Emergency Service (P10)		Greater	Logistic	Nursing
Over referencing by basic emergency services (P3)		Greater	Administration	Logistic
Patient's stay in the Emergency Service for 12 and often 24 hours (P8)		Greater	Computing	Nursing
Inadequate space (P4)		Lower	Operations	Management
Limited number of computers available to professionals (P1)		Lower	Administration	Nursing



In summary, we can state that, in the scope of a stable Interstructure for the 2014-2016 period, 2014 was less stable in terms of performance of the CP and in the production of the CT.

Compromise analysis aims to study the main similarities and differences in the collections conducted in the CP and the following CT for 2014-2017. Reproduction using factor plans of the Compromise matrices allowed us to assess the possibility of defining common structures throughout the stability detected in the period 2014-2017. The Euclidean representation of the Compromise in the CP regarding to the top ten of CT is shown in Figure 7. Three patterns were detected in both structures; in both cases, pattern 2 was the one that most contributed to the description. In Figure 7, we can see that patterns 2 and 3 are those that most contribute to Axis 2 of Compromise, which presents a gradient that increases right to left. In fact, this dimension of the analysis links the occurrence of Repeated samples (V7), Nº of Samples and Recollected samples (V3) with the samples associated with the paying entities. The most predominant relation is with the National Health Service (V4), followed by Insurance and the least relevant is with Private (V5). The variable Registration errors (V2) is the least contributing variable. Thus, in view of Figure 7 (a), Axis 1 was named PRODUCTION PER PAYING ENTITY.

#### 4. Conclusions

Applying DISTATIS methodology allowed relations to be identified between this emergency services main operational areas and the stability among the experts' opinions regarding the top ten issues/challenges for service performance.

Applying sorting tasks to classify and order the identified issues/challenges allowed management activities to be prioritized.

Space configuration of the DISTATIS infrastructure allowed us to see the positioning of the studied issues/challenges and understand the differences in classification among the experts of the different operational areas.

Two representative dimensions were designated and characterized of the issues in emergency services of the University Hospital of Algarve in Faro – HUMAN AND MATERIAL RESOURCES (Axis 1) and USERS AND EQUIPMENT (Axis 2).

By identifying the issues/challenges for which the matching was higher among the different emergency services areas, we were able to clarify both the interventions for which there was most consensus among the experts and the areas for improvement through activities promoting standardizing or realignment.

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