Time Management in Diagnostic Medicine

Eleonora Santos and Shahed Khan

University of Coimbra

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Eleonora Santos[1] & Shahed Khan [2]

[1]*Centre for Business and Economics Research – CeBER. Faculty of Economics. University of Coimbra. Avenida Dias da Silva, 165. 3004-512 Coimbra, Portugal.*

[2]*University of Surrey. Guildford, UK.*

Abstract – The supply chain management, by allowing the reduction of costs in logistics operations constitutes a strategic organizational asset. This paper focuses on time management in a Diagnostic Medicine facility. It aims to determine the level of time compression for 5 diagnostic examinations. Bearing this in mind, we collect the length time of each task concerning each examination and elaborate the descriptive statistics in STATA 13.0; while the process of optimization is implemented using the DMAIC approach. Our results show that total waiting time for all 5 examinations per week is 4 hours and 16 minutes and that, implementing some recommendations, the facility could perform 35 more examinations per week. This is of importance, not only in the context of cost reduction, but also to increase efficiency and improve the quality of service. Ultimately, the implementation of our recommendations will increase patients' satisfaction.

Key words- Logistics & Supply Chain Management, Customer Service Management, Quality of Service, Diagnostic Medicine, Patients' Satisfaction

1. INTRODUCTION

In a globalized world, firm operations are significantly challenged by customization, competition and clients' expectations, in addition to supply side disruptions (Hanfan & Setiawan, 2018). These challenges require improved efficiency and flexibility in manufacturing, services and supply chain systems. New concepts and models offer a potential method to such operational improvements. In this context, issues such as, for example, optimal strategies under competition and optimal operations with strategic consumer behaviors are being examined (Cronin, Brady, & Hult, 2000). Indeed, supply chain management has been a focus of research in recent years thanks to its important role in firms' performance (Habib, 2011). The integration of supply management and distribution management features has resulted in the concept of an extended enterprise; and the supply chain is now manifested as the collaborative supply chain between companies to maximize the value of the supply chain (Post, Preston, & Sachs, 2002).

Health services have recently undergone significant changes in Portugal, where several operational and management activities have incorporated new requirements mainly regarding the acquisition, transport and distribution of supplies and equipment (Thierry, Martijn and Salomon, Marc and Nunen, Jo Van and Wassenhove, 1995). This resulted from the need to improve the planning, control and quality of services provided in medical treatments, with the main objective of improving patient care. Stakeholders of health systems such as governments, private institutions, practitioners and users, among others, have explored widely these requirements. This paradigm shift has encouraged the active participation of users in decision-making processes. However, each participant has its own view and perspective regarding the increase of efficiency, the improvement of the quality of services and the minimization of costs. While the performance of healthcare activities should contribute to the improvement of the quality of services provided and patients' satisfaction; the weak performance of institutions can jeopardize lives that need higher quality of organizations and professionals who provide this service. This is of particular importance in a context of several imbalances in terms of health services available throughout the country and a decrease in patients' satisfaction with the NHS over the period 2000-2016 (Santos & Khan, 2018). Consequently, healthcare providers face the challenge of managing (sometimes) tight budgets; while maintaining the quality of service provided, in order to increase the competitiveness of their institutions.

In view of the above, this paper aims to conceptualize and define performance measures for the logistics of health services and their challenges. For this purpose, it contextualizes factors, objectives and contribution to enhance the quality improvement in the healthcare institution. In what follows, section 2 describes the methodology; section 3 analyzes and discusses the results and provide some recommendations; and section 4 concludes.

2. METHODOLOGY

We start by collecting the length time of each task concerning each examination performed in a public healthcare provider, providing clinical diagnostic procedures in its facilities. The Conventional Nuclear Medicine (CNM) service consists of the administration of radiopharmaceuticals for diagnostic purposes and imaging. In a subsequent phase we elaborate the descriptive statistics in STATA 13.0.

The CNM service integrates 11 full-time employees and 5 part-time collaborators, as show in Table 1.

Table 1- Staff Description

	Number
Resident staff:	
Physician (NM)	2
Physicist (NM)	1
Technician (NM)	3
Technician (clinical analysis)	1
Clerk	4
Collaborators:	
Cardiologist	2
Nurse	2
Technician	1

The Positron-emission tomography (PET) imaging service is located on floor 0, where the 4 gamma-chambers are located, as well as a radiopharmaceutical laboratory, where the radiopharmaceuticals are prepared; a room where they are administered to the patient; a waiting room; and facilities that are exclusive for patients after the uptake of the radiopharmaceuticals. The most commonly used radiopharmaceutical in PET is ^{18}F-fluorodeoxyglucose (FDG), particularly in Oncology, where it is accurate in the detection and staging of tumors, in monitoring the response to therapy; and in the differentiation between benign and malignant lesions.

The intended optimization focuses on the CNM service that is performed daily at the Institution. The implementation of Six Sigma methodology aims at optimizing the various processes developed in the CNM service and establishes the existence of five phases (DMAIC). The DMAIC approach (Define, Measure, Analyze, Implement and Control) is a structured problem-solving method aiming at implementing long-term solutions to problems, where each phase builds on the previous one.

Phase D. Defines which processes are targeted for possible optimization, identifies the characteristics of the process that needs to be optimized, the main inherent tasks and the associated problems. Information about the frequency of examinations was collected in July, as shown in Table 2.

Table 2-Data related to the examinations in January

Examinations	**Number of examinations**
Examination 1	56
Examination 2	28
Examination 3	12
Examination 4	16
Examination 5	20
Total	**132**

For the purpose of this research, the implementation of Six Sigma methodology aims at reducing patients' waiting time during the examinations and the time they wait for the results. After establishing the objectives, we mapped the main workflows.

Workflow mapping plays a crucial role in the first phase of the process optimization, since it allows the characterization of the *status quo* and the identification of the critical points, in order to facilitate the reduction of errors, increase productivity and improve the quality of service. Interviews and informal discussions were held with the human resources involved in the process. Particular importance was devoted to identifying variations between processes in order to facilitate a better understanding of the various practices established in the CNM service.

We now describe the tasks for each process related to the 5 examinations.

Step 1: Admission. This step integrates the following tasks. 1. The patient asks to be admitted to the service, in the reception; 2. The clerk registers all information about the patient in the patient's file and informs him if any payment is due; 3. If it is the case, the patient pays; 4. The patient awaits call in the waiting room; 5. The clerk calls the patient; 6. The clerk accompanies the patient to the conditioned access area, indicating the place where the patient should remain.

The critical points of this step are identified in Table 3

Table 3- Tasks that can be eliminated/minimized regarding patients' admission

Description	Stakeholders	Critical point
Start Patient's file	Clerk	Information on paper
Waiting	Patient	Waiting time
Travelling to conditioned access area	Clerk	Transport the information on paper

Step 2: Examinations-The critical points of this step are identified in Table 4

Table 4- Tasks that can be eliminated/minimized

Description	Stakeholders	Critical	Examinations
Travelling to functional room; travelling to the physician's office to deliver the medical file	Clerk	Unnecessary travel	All
Moving the file to the functional room; moving the file to the gamma-chamber 2; travelling to the gamma-chamber; travelling to the injection waiting room; travelling to the waiting room	Technician (NM)	Availability of another technician; unnecessary travel	All but examination 4
Travelling to the WC; await call; staying in the corridor; staying in the waiting room; water ingestion	Patient	Technician awaits for the Patient; waiting time	All
Moving the file to the radiopharmaceuticals uptake room; moving the file to the gamma-chamber; travelling to the gamma-chamber	Physician	Unnecessary travel	All but examination 4

Step 3: Processing examinations and sending the results. This step is not performed immediately after the end of *Step 2*; and the interval may vary according to the examination.

Table 5- Tasks that can be eliminated/minimized in Step 3

Description	Stakeholders	Critical point	Examinations
Moving the file to the processing room	NM Technician	Unnecessary travel	All but Examination 4
Print images and attachments	NM Technician	Information on paper	All
Data entry	Clerk	Data already in digital format	All
Moving the file	Technician (Clinical Analysis)	Unnecessary travel; information on paper	Examination 4
Move medical record to the medical office	Physician	Unnecessary travel	All
Examination report	Physician	Obliges transcription	All
Move the tape recorder to the clerk's office.	Physician	Unnecessary travel	All
Transcript of medical report	Clerk	Mandatory transcription	All
Move medical report to the medical office	Clerk	Unnecessary travel	All

Phase M. In this phase we calculate the length of each task. Given the impossibility of being simultaneously in the conditioned access area and in the waiting room, the data collected for step 1 were not obtained by direct observation. The scheduled time (appointment time for the patient to be admitted to the service) has been consulted according to the patient's name in the daily check-in system; while the time of admission has been collected from the patient's file and corresponds to the time of admission upon arrival at the service. The scheduled time and the time of admission were collected in the format (hours: minutes). Regarding data collection for step 2, the time was collected in the format (hours: minutes: seconds) referring to the beginning/end of the tasks in which the patient intervenes. These data were collected in the conditioned access area, according to the examination. The number of examinations results sent was also collected.

Phase A. Based on data collected on the previous phase, the average length of the various tasks was calculated.

3. RESULTS

Table 6 presents the Sample representativeness. Examinations 5 and 3 are better represented, while the samples of examinations 1 and 2 represent only 29%, on average.

Table 6. Sample representativeness

Examinations	Number of examinations		Representativeness (%)
	Average /week	Our sample/week	
Examination 1	46	14	30
Examination 2	25	7	28
Examination 3	5	3	60
Examination 4	9	4	44
Examination 5	7	5	71

Examination 1. This examination is performed daily and have a high frequency because of the availability of 3 gamma chambers. The patient spends approximately 15% of time before entry into the medical office. After the consultation, the patient waits for entrance into the radiopharmaceuticals uptake room, on average, more than 40 minutes, which represents 12.64% of the total time of staying in the facility. The uptake of the radiopharmaceutical takes 2 hours and 30 minutes to 3 hours. Therefore, the average waiting time for the entrance into the Gamma Chamber (02:41:03) is between the recommended values.

Table 7. Length of tasks involving the presence of the patient in Examination 1

Task	Average Task Length (mean ± St. Deviation)
Initial wait (from admission to entry into the conditioned access area)	00:36:40 + 00:30:54
Wait for entrance into the medical office.	00:12:39 ± 00:19:14
Stay in the medical office	00:06:11 ± 00:01:50
Wait for entrance into the radiopharmaceuticals uptake room	00:41:45 ± 00:43:45
Permanence in the radiopharmaceuticals uptake room	00:04:43 ± 00:04:36
Wait for entrance into Gamma Chamber	02:41:03 ± 00:18:45
Stay in the Gamma Chamber	01:07:20 + 00:17:44
Total time	05:30:21 ± 00:49:13

Examination 2. This examination is performed on a daily basis, since the service has a gamma chamber dedicated to this examination exclusively. The patient waits on average about 25 minutes, consuming approximately 27% of the total time in the service. After the patient's exit from the medical office, the waiting time is 00:08:24, which may be due to the preparation of dose to be injected or to an adaptation of schedule with those of other patients for the same examination. After the uptake of the radiopharmaceutical the patient should wait between 15 and 30 minutes, the ideal being 20 minutes. Instead the patient waits on average about 32.5 minutes, which means an effective waiting time of 12 minutes.

Table 8. Length of tasks involving the presence of the patient in Examination 2

Task	Average Task Length (mean ± St. Deviation)
Initial wait	00:12:44±00:15:58
Wait for entrance the medical office	00:11:53 ± 00:08:22
Stay in the medical office	00:05:55±00:02:40
Wait for entrance into the radiopharmaceuticals uptake room	00:08:24±00:08:09
Permanence in the radiopharmaceuticals uptake room	00:04:38±00:03:19
Wait for entrance into Gamma Chamber	00:32:32±00:13:26
Stay in the Gamma Chamber	00:14:00±00:07:33
Total time	01:30:07±00:32:50

Examination 3. It takes, on average, 1 hour and 21 minutes, of which about 35% is spent waiting before entering the medical office. In addition to the first two waiting tasks, the patient still waits about 14 minutes to enter the gamma chamber.

Table 9. Length of tasks involving the presence of the patient in Examination 3

Task	Average Task Length (mean ± St. Deviation)
Initial wait	00:14:53±00:14:50
Wait for entrance the medical office.	00:13:44±00:12:10
Stay in the medical office	00:05:07 ±00:01:56
Wait for entrance into Gamma Chamber	00:14:13±00:13:52
Stay in the Gamma Chamber	00:33:45±00:04:43
Total time	01:21:42±00:28:48

Examination 4. This examination does not take place either on Mondays or Fridays, due to issues related to human resources management. According to Table 10, the patient waits nearly 69% of the total time.

Table 10. Length of tasks involving the presence of the patient in Examination 4

Task	Average Task Length (mean ± St. Deviation)
Initial wait	00:30:47 ± 00:39:58
Wait until you enter the Examination 4 room	00:10:44 4 00:13:59
Permanence in the Examination 4 room	00:19:03 ± 00:03:45
Total time	01:00:35±00:40:22

Examination 5. These examinations usually do not take place on Mondays. According to Table 11, the waiting time before entering into the medical office represents almost 26% of the total time.

Table 11. Length of tasks involving the presence of the patient in Examination 5

Task	Average Task Length (mean ± St. Deviation)
Initial wait	00:11:50 ± 00:13:31
Wait for entrance the medical office.	00:18:11 ± 00:12:17
Stay in the medical office	00:05:33 ± 00:01:57
Wait for entrance into Gamma Chamber	00:11:24 ± 00:09:04
Stay in the Gamma Chamber	00:34:00 ± 00:09:58
Wait for 2nd entrance into Gamma Chamber	00:36:52 ± 00:18:50
2nd Stay in the Gamma Chamber	00:07:24 ± 00:11:55
Total time	02:05:14 ± 00:34:39

To sum-up, Table 12 shows the amount of time that could be reduced or eliminated, by type of examination

Table 12. Necessary versus total time spent in the examination

Examinations	Time (minutes)		Potencial Time-Saving (minutes)
	Total	Necessary	
Examination 1	330	258	72
Examination 2	90	44	46
Examination 3	81	38	43
Examination 4	60	19	41
Examination 5	125	71	54
Total			**256**

The analysis of Table 12 shows that examination 1 takes more time and if the waiting time could be eliminated it would reduce the waiting time in 1 hour and 12 minutes for each patient, increasing their satisfaction with the service. Examination 4 is the one that takes less time, about 1 hour. Nonetheless, if proper measures could be taken, it would save 41 minutes to each patient.

Data for step 3 are included in Table 13. The results of examinations 3 and 4 can take more time to be sent to the patients; while examinations 1 can take less time.

Table 13. Time elapsed between examinations and sending the results

Examinations	Number of examinations	Time elapsed (Business days)
Examination 1	352	4-5
Examination 2	174	3-6
Examination 3	28	5-8
Examination 4	64	3-8
Examination 5	45	5-6

Phase I. Based on protocols, some suggestions may be provided. First, we suggest the reformulation of the examination schedules to reduce the total waiting times. A constant number of examinations per day should ideally be accomplished to maintain the average number of examinations per week and, thus, increase the efficiency and patients' satisfaction. Should the suggestion is implemented the number of examinations per week can increase to 127.

Table 14. Number of examinations after the proposed reformulation of the schedules

Examinations	Number of examinations/ week		
	Before	**After**	**Increase**
Examination 1	46	59	13
Examination 2	25	28	3
Examination 3	5	10	5
Examination 4	9	15	6
Examination 5	7	15	8
Total	**92**	**127**	**35**

To ensure the quality of the service, a medical helper could be hired to accompany patients leaving technicians available for other tasks and avoiding unnecessary waits. To avoid unnecessary travel to call patients and considering that the different rooms are properly identified, patients could be called through a loudspeaker system installed in the waiting rooms.

The number of technicians in the service (3) is not enough to cope with the amount of labor and the number of gamma chambers installed in the service. Indeed, the Protocol mentions the mandatory presence of 2 NM technicians per gamma-chamber (Ministério da Saúde, 2002); one allocated to the task of patient positioning and another allocated to data entry.

Furthermore, there is a need to expedite the oral reporting file. The physicians could write the medical report, avoiding their transcription and unnecessary travel. This should be done using a recorder that allows immediate transformation of voice to text using the appropriate software. Finally, examination results could be sent via online, in order to speed the process.

Phase C. This step is inoperable since only a few suggestions for implementation were provided.

Caveats. This analysis has two caveats. First, the time of patient arrival was not controlled which means that the waiting time, if any, between the patient's arrival and the admission was not controlled. Instead we assumed that the patient goes immediately to reception to ask for admission. Second, the exact time of the radiopharmaceutical uptake should have been taken into account for all examinations with the exception of Examination 4 that does not include radiopharmaceuticals uptake. The time could have been collected once registered in the patient's file by the NM technician at the time of the uptake. Instead, the time was collected when the patient leaves the radiopharmaceuticals uptake room, which could introduce some error.

4. CONCLUSION

The purpose of this paper is to optimize the CNM service regarding the minimization of patient waiting time and to provide some recommendations to improve the quality and efficiency of the service. This study contributes to the systematization of a CNM service, by highlighting the critical points that can be eliminated, or which length can be reduced. The implementation of our suggestions can lead to the reduction of both the length of some tasks and the waiting times. In this regard, the reformulation of examination schedules is crucial. As most of the suggestions have not yet been implemented, the control could not be attained. Notwithstanding, the dialogue with the intervening professionals allowed to perceive the complexity of CNM service. Thus, efforts must be combined to foster a good interpersonal relationship, an implement an assertive communication, professionalism and flexibility / accessibility among the team.

References

Cronin, J. J., Brady, M. K., & Hult, G. T. M. (2000). Assessing the effects of quality, value, and customer satisfaction on consumer behavioral intentions in service environments. *Journal of Retailing*, *76*(2), 193–218. https://doi.org/10.1016/S0022-4359(00)00028-2

Habermann, M., Blackhurst, J., & Metcalf, A. Y. (2015). Keep Your Friends Close? Supply Chain Design and Disruption Risk. *Decision Sciences*, *46*(3), 491–526. https://doi.org/10.1111/deci.12138

Habib, M. (2011). Supply Chain Management (SCM): Theory and Evolution. *Supply Chain Management - Applications and Simulations*, (September 2011). https://doi.org/10.5772/24573

Ministério da Saúde (2002). Decreto-Lei n.º 180/2002 de 8 de Agosto. Diário da República - I Série-A, nº182.

Ordem dos Médicos (2003). Manual de boas Práticas em Medicina Nuclear. Colégio de Medicina Nuclear. Portugal.

Post, J. E., Preston, L. E., & Sachs, S. (2002). Managing the Extended Enterprise: The New Stakeholder View. *California Management Review*, *45*(1), 6–28. https://doi.org/10.2307/41166151

Santos, E., & Khan, S. (2018). Patients' Satisfaction with the NHS: A Novel Indicator for Portugal. *International Journal of Healthcare Education & Medical Informatics*, *5*(May), 2455–9199. https://doi.org/10.24321/2455.9199.201803

Schulthess G. K. (2006). Molecular anatomic imaging: PET-CT and SPECT-CT integrated modality imaging, 2nd edition. Philadelphia: Lippincott Williams & Wilkins.

Thierry, M., Salomon, M., Nunen, J.V. and Wassenhove, L. V. (1995). Strategic issues in product recovery management. *Long Range Planning*, *28*(3), 120. https://doi.org/10.1016/0024-6301(95)91628-8