

The thinking process of the theory of constraints applied to public healthcare

TP–TOC
applied to
public
healthcare

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Abstract

Purpose – The purpose of this paper is to present an approach based on the thinking process of the theory of constraints (TP–TOC) to support decision-makers, managers and professionals of health to diagnose and improve healthcare systems focusing on the service quality deployed to patients.

Design/methodology/approach – A case study was developed in a SUS-affiliated philanthropic hospital in southern Brazil, through the analysis of its ED processes and application of the TP–TOC. The Current Reality Tree and the Evaporating Cloud tools of the TOC were used to identify the root causes (RC) and their connections with undesirable effects.

Findings – The analysis of this case helped to understand and identify the causes of the current problems in the analyzed processes related to internal management and external causes. The proposed approach allowed the hospital team to progress in the understanding of such causes in a sequential manner, giving conditions to support different perceptions and to identify relevant facets and causes related to the problem. The research provided a systemic and an integrated vision of the losses in the organizational processes and indicated the steps to be prioritized in order to eliminate such losses.

Originality/value – The paper proposed an approach that allowed the systematic and systemic analysis of organizational processes through the application of the TP–TOC. The recognition of the existence of RC responsible for processes losses represents an excellent opportunity for improvement because it allows managers to focus their efforts on the more productive areas.

Keywords Hospitals, Theory of constraints, Current reality tree, Public health

Paper type Case study

1. Introduction

Brazil recorded in 2016 a gross domestic product (GDP) of \$1,913bn, accounting for 8.51m square kilometers and about 200m inhabitants (IBGE, 2017). Brazil investment in healthcare public services raised from 1995 to in 2014 from about 6.5 percent to about 8.3 percent of the GDP (WHO, 2017). However, despite the increment of the investment, Brazil holds one of the lowest worldwide investments in this kind of public service (Anahp, 2015). Even if compared to other Latin American countries, such as Argentina and Chile, Brazil's expenses on public healthcare are significantly lower (WHO, 2017).

The Brazilian public system offers free and universal healthcare service to the entire population. The Brazilian Unified Health System (SUS) covers consultations and treatments recognized by the current legislation to the entire population, without any additional charge (PWC, 2013). Ensured as a universal, equal and sustainable right by the Brazilian constitution of 1988, about 76 percent of the Brazilian population depend solely on the SUS health services (Anahp, 2015; Kuchenbecker and Polanczyk, 2012; Victora *et al.*, 2011).

The system relies on service providers, as public and private philanthropic hospitals (Anahp, 2015). While committed to their mission of reestablishing health to patients, these organizations need to provide services in a sustainable fashion, leading to a trade-off between service quality, availability and cost management. To find equilibrium and to ensure sustainability in the long term to this service is a significant problem (Paim *et al.*, 2011). The SUS is a fundamental structure for healthcare in Brazil, as a significant part of



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the Brazilian population is not able to access the private system (PWC, 2013). Nevertheless, SUS services are often associated to low quality, inefficient resources management and poor infrastructure (Alástico and Toledo, 2013; Anahp, 2015; La Forgia and Couttolenc, 2008; Paim *et al.*, 2011). Service quality, as well as long waiting time, is recurrent complaining of the population (Alástico and Toledo, 2013; Burmester *et al.*, 2007; La Forgia and Couttolenc, 2008). For example, patients waiting for non-critical surgeries may take up to 36 months to be served (Souza *et al.*, 2016).

Under a global perspective, there has been an upward trend in the demand for quality in healthcare services as well as increased expectations and requirements of cost reduction. To be sustainable, health systems must focus on continuous improvement of their processes, to avoid wasting resources or time. Healthcare providers should be able to use information effectively to serve the community, preserve efficiency and assure the quality of the service (Snyder *et al.*, 2005).

The theory of constraints (TOC) may contribute to improving decision making in conflicting situations (Goldratt, 1994) like those found in healthcare service systems. The TOC aims to solve unstructured or ill-defined problems and also to identify cause-and-effect relationships that may generate constraints (Mabin *et al.*, 2010). Applications of TOC in healthcare services are observed in association with computer simulation-based studies (Gunal, 2012) or lean thinking (Mazzocato *et al.*, 2010; Poksinska *et al.*, 2016; Souza, 2009). The main issue is to identify bottlenecks, reduce wastes, decrease lead times and balance the flow of patients.

The analysis of hospital organizations from a TOC perspective can contribute to improving the quality of the provided services (Gupta and Kline, 2008; Nematipour *et al.*, 2014). Nevertheless, the application of the TOC in the hospital context is still incipient, particularly in Brazil (Pergher *et al.*, 2016; Ren *et al.*, 2013; Souza *et al.*, 2016; Wadhwa and Schleier, 2010). Therefore, the purpose of this paper is to propose an approach based on the thinking process of the theory of constraints (TP–TOC) to support decision-makers to diagnose problems and improve healthcare service systems performance, focusing on the quality of the service. The research method is the case study.

This research relies on the perspective of a SUS-affiliated hospital. As a mean to discuss how the TP–TOC may support the improvement of healthcare service systems focusing on the service to the patient, a case study was developed in a philanthropic hospital in southern Brazil. Process analysis and the application of the TP–TOC were used to compile information from internal documents, observation, publicized material and data gathered in interviews. The Current Reality Tree (CRT) and the Evaporating Cloud (EC) tools of the TOC were used to identify the root causes (RC) and their connections with undesirable effects (UEs). The experience from this study, combined with the literature background permitted to propose the main result of this research.

The justification of using TOC in public healthcare service systems relies mainly in the capacity of TOC in handle conflicting systemic situations without using advanced analytical or probabilistic solutions. Other approaches such as computer simulation or lean healthcare require software packages, literature background and advanced support from experts, which are rarely available in public healthcare service systems. TOC tools are intuitive and easy to communicate. Therefore, managers and practitioners of public healthcare service systems can easily employ and explore the set of TOC tools to manage conflict situations and quickly find suitable solutions. Other managers and practitioners of public healthcare service systems can use the TOC approach by applying the TOC tools in focusing the conflicting situations of their organizations to uncover the main problems and to propose ultimate solutions.

The use of TOC is not novel in healthcare service systems. To ground the study, we extracted some applications from the literature to explain how other studies had already used the TP–TOC, which can also help to understand how managers and practitioners would use the approach to improve the performance of their systems.

Pergher *et al.* (2016) carried out a TP-TOC case study in the process of authorization of radiotherapy service in a large Brazilian hospital. The main results allowed the definition of a set of actions to eliminate or reduce the failure modes in their healthcare system. Souza *et al.* (2016) analyzed the case of another large Brazilian hospital to improve bed management using the TP-TOC. The research promoted an in-depth understanding of the problems associated with the management of hospital beds and driven actions to reduce wastes.

Stratton and Knight (2010) used TP-TOC to analyze the flow of patients in hospitals in England and the Netherlands, reducing the waiting time of patients by 20 percent. Tsitsakis (2010) applied the TOC in five public hospitals in Greece, aiming to solve capacity problems, long waiting lists and low occupancy rate in hospitals. Groop *et al.* (2010) suggested a constraint-based alternative to increase the transfer rate rather than reduce costs in a home healthcare service in Finland. Nematipour *et al.* (2014) described the application of the TP-TOC in the hospital supply chain of five hospitals in Iran and uncovered the core problem, the environmental instability, which requires larger inventories to prevent shortages. Finally, Ren *et al.* (2013) demonstrated how the TOC's five focal steps can be applied to the surgical process, to increase the number of surgeries, reduce overtime and increase the patient's satisfaction.

The following sections present a background on the TOC and TP-TOC in the context of healthcare, the methodological approach and the results of the research. The paper ends drawing some considerations regarding the produced results in the context of healthcare.

2. Background

2.1 The TP-TOC

The TOC focus on elements that limit the ability of an organization to achieve its goal. These elements are referred as constraints. TOC was initially created to improve production and distribution systems, latter evolving to supply chain management, marketing and strategy (Cox and Spencer, 1999; Polito and Capen, 2014; Rahman, 2002; Watson *et al.*, 2007). Its use also encompassed service organizations and non-profit institutions (Motwani *et al.*, 1996a; Watson *et al.*, 2007).

According to Cox and Spencer (1999), TOC comprises three key approaches:

- (1) The logistics approach: the management of buffers, the sequencing of production by the drum-buffer-rope algorithm (DBR), and the analysis of the V-A-T production structure (disassembly, assembly and transformation lines).
- (2) The five focusing steps approach: the identification, subordination and exploitation of the main constraint of a system, by increasing its capacity, the capacity of the whole system is increased as a result.
- (3) The TP-TOC approach: the use of cause-and-effect diagrams to resolve organizational problems. The recommended tools are the Current Reality Tree (CRT), the Future Reality Tree (FRT), the Prerequisite Tree (PRT), the Transition Tree (TT) and the Evaporating Cloud (EC) diagram.

Organizational constraints can be either physical (a machine with lower capacity, suppliers, people) or non-physical (the market, policies, procedures, standards and skills, daily practices, thinking models) (Kendall, 2004). To explore non-physical restrictions, it is recommended to use TP-TOC (Gupta and Boyd, 2008; Motwani *et al.*, 1996a).

As the TOC seeks to identify the core problem associated with UEs, the TP-TOC may support answering the three questions related to the organizational performance: "what to change"; "what to change to" and "how to cause the change" (Dettmer, 1997). To do so, the

operational tools represented in Table I are utilized. Each tool requires a methodological procedure to be constructed. Further discussion can be found in the studies of Cox and Spencer (1999), Gupta *et al.* (2004), Kim *et al.* (2008) and Noreen *et al.* (1995).

The TP–TOC, made operational by the tools above, is considered a Socratic method, that uses propositions in the form of “if [...] so [...]” (Motwani *et al.*, 1996a; Ritson and Waterfield, 2005). It contributes to self-disclosure, encouraging engagement and participation to focus changes on the weakest link (RC) of a problem. The RC is responsible for most of the UEs that hinder the organization on achieving better performance (Reid and Cormier, 2003; Taylor and Churchwell, 2004).

The process allows the explanation of the managers’ insights, who are usually unaware of the real problems of the company in which they act, much less of the solution to them (Goldratt, 1990). The CRT, for example, allows managers to work from the effects (above) down to the causes (below) in a top-down logic. Then, the tree interpretation is given toward bottom-up, using conditional relations established (Gupta *et al.*, 2004). When an effect is promoted by two or more causes, it becomes necessary to verify the conjunctions of causes that cause the effect. This analysis may result in a logical operation “or” or a logical operation “and.” The second case represents the obligation of a conjunction of causes, being represented by an ovate symbol. It marks the situations where there may occur insufficiency of causes to generate an effect (Wright and King, 2006). The trees drawn up by the actors involved serve as a means to exchange and widespread information and knowledge.

2.2 TOC studies in healthcare organizations

Motwani *et al.* (1996a, b) conducted theoretical studies about the use of TOC in healthcare organizations. Wadhwa and Schleier (2010) identified the five focusing steps, the TP–TOC and the buffer management as the most used tools in public health. In addition to those, 25 articles published between 1999 and 2016 were identified: 9 related to the five focusing steps; 14 related to the TP–TOC; and 2 related to buffer management. Table II presents a

What to change?

Current Reality
Tree (CRT)

The CRT presents hypotheses and possible causes of problems. It allows representing secondary effects that, when confirmed, justify the existence of a prior cause. The CRT allows the identification of a core problem that resonates into several UEs, unresolved conflicts or erroneous assumptions

What to change to?

Evaporating Cloud (EC)
diagram

The EC diagram allows checking the assumptions related to the conflict or core problem and understanding why the problem was not resolved. It forces to explicit existing assumptions related to the core problem, to solve (evaporate) it by generating a new conception of the situation

Future Reality
Tree (FRT)

The FRT organizes potential solutions to the problem in relation to the UEs arising from the CRT. The FRT allows identifying the changes required from actions, as well as to prevent problems that can arise from the solution implementation

How to cause the change?

Prerequisite Tree (PRT)

The PRT identifies obstacles that prevent the implementation of the solution. The PRT allows defining intermediate goals that span potential obstacles and enables the development of an action plan to achieve the FRT

Transition Tree (TT)

The TT identifies actions necessary to achieve the stated goals. It represents the stages and phases of transition from the current situation to a desired (future) situation

Negative Branch (NB)
diagram

The NB diagram allows constructing and experimenting possible solutions prior to the effective selection of a course of action. It focuses on identifying the impacts and any negative effects related to each action taken

Table I.

The TP–TOC tools

Sources: Adapted from Cox and Spencer (1999), Mabin *et al.* (2010) and Polito and Capen (2014)

(continued)

Authors	Objective	Method	Results
Womack and Flowers (1999)	To increase the number of patients served, to increase revenue and to control costs to make the business viable	A case study with the application of the TOC's five focusing steps was carried out in the 366th Medical Group, a unit of the US Air Force in Idaho	The patient waiting times have been reduced. The satisfaction of customers and employees has improved and the capacity has increased by 800 patients monthly, generating revenues of \$1.6m and a cost reduction of \$200,000
Kershaw (2000)	Focus on the excessive (long) waiting times for patients in the chemotherapy department	A case study with the application of the TOC's five focusing steps was carried out in the chemotherapy sector of a for-profit cancer clinic	The results reported an increase in the processing capacity of patients of 20% to 25% per day. Furthermore, the average treatment time was reduced from 2.5 h to less than 2 h
Hunink (2001)	To identify which heart procedure, a carotid endarterectomy should be performed prior to coronary artery bypass in the treatment of a patient	A TP–TOC analysis was conducted and EC diagrams were analyzed	The results recommend avoiding the carotid endarterectomy procedure in order to avoid the risks and costs in the treatment of a patient with asymptomatic characteristics
Rotstein <i>et al.</i> (2002)	To build a statistical model to predict the need for allocation of additional doctors in the emergency department (ED) of the hospital	Application of the TOC's five focusing steps in the hospital's ED for immediate stabilization and admission of patients	With the increased capacity, the patients' waiting time was reduced by an average of 7.01 min. However, when the number of patients is less than 80 or more than 120, the increase of medical professionals has caused no impact on waiting indexes. The impacts depended on the availability of physicians being a constraint
Taylor and Sheffield (2002)	Analysis of the filing, processing and tracking of medical insurance claims	A case study was carried out in a call center of a for-profit hospital in Texas. TP–TOC and tools as CRT, EC and FRT were applied	Training and qualification were provided to the employees to ensure the reduction of overdue requests, prepayment of the same and to increase profit margins
McNutt and Odwazny (2004)	To provide a conceptual framework for the identification of causes of medical errors in the Rush University Medical Center	TOC was used to review the adverse events and the impact of clinical decisions and care processes on errors. A timeline with a list of all the decisions and the processes involved in the care of patients. The chain of events leading to adverse events was modeled through the CRT	It became evident to the managers the need for cost reduction to increase the gain and not just investments in diverse resources. This perspective has helped with the planning of interventions, the reduction of adverse events and it has contributed to improving the safety of people and materials. Therefore, it was possible to increase the health and medical care involving the addition of people and materials. Therefore, it was possible to increase the safety and simultaneously reduce inventory and operating expenses

Table II. Summary of TOC application studies in health systems

Table II.

Authors	Objective	Method	Results
Silvester <i>et al.</i> (2004)	To evaluate the causes of excessive waiting lines in the National Health Service (NHS) and delays in the patients' care	A theoretical study on the National Health Service (NHS) in England and the possibility of application of the TOC in the healthcare sector	The main cause of long queues was not the lack of capacity, but the variation and mismatch between capacity and demand. The increase in availability of non-bottleneck processes resources did not generate improvements in the system. The reduction of waiting times would only be achieved by improving the flow of patients, management of bottlenecks and variation reduction
Taylor and Churchwell (2004)	To analyze the budget constraints in a hospital	A case study in a not-for-profit psychiatric hospital in Texas, using the TP-TOC and tools as CRT, EC and FRT	The constraint identified was the legislative funds. As a result of the application of TOC, there was an improvement in the quality of care, reduction of staff overwork and improvement of staff morale
Lubitch <i>et al.</i> (2005)	To analyze the impacts of TOC in three NHS Trust departments, neurosurgery, ENT, Eyes and to reducing waiting lists in the system and improving the throughput of patients	A case study based on the TOC's five focusing steps in three departments of a hospital in the UK (Radcliffe Infirmary (RI), in the departments of neurosurgery, eye and ENT. Data were collected over a period of 40 months	With TOC application, on average, 184 people per month were attended in less than 30 min, and 108 Department of Otolaryngology (ENT). The total number of patients on the waiting list has decreased in all of them. There were no significant improvements in the neurosurgery department which are associated with the complexity of the system. And the bottleneck identified was the lack of nurses in the hospital wing
Ritson and Waterfield (2005)	To identify how the National Health Service (NHS) and the Social Services Department (SSD) could manage changes in the local mental health service	A case study in the mental health service for adults living in the North East of the UK, applying TP-TOC, and tools as CRT, EC, FRT, PRT and TT	As a result of the study, the introduction of a Crisis Resolution/Home Treatment Teams allowed the reduction of time to admissions and the length of stay in the hospital. The quality of treatments has improved for users of services both at home and in the hospital as well
Sellitto (2005)	To analyze the management of repeated use materials in the public health of a Brazilian capital in order to improve the assistance to managers of community healthcare service centers regarding the required materials in quantity and time	A case study applying the TP-TOC in a public health organization. The following tools have been applied: CRT, EC, FRT, PRT and TT	An increase of 60% of units delivered per month. The average stock has been reduced by approximately 15% and turning stock climbed about 2:30 times a year for about five times a year. The complaints from managers of healthcare service centers, which were frequent until then, have been zeroed. Shortages of materials amounted to negligible levels

(continued)

Authors	Objective	Method	Results
Parwarddhan <i>et al.</i> (2006)	To provide appropriate technical reports to the clinic and public health policymakers in the Center of Practical Evidence (evidence-based practice centers (EPCs))	A case study applying the TP-TOC, and the CKT and FRT tools	Improvement in the process of developing technical reports on the basis of evidence that really informed decisions of great importance to the EPCs and to policymakers
Umble and Umble (2006)	To reduce the waiting time and admission to the accident and emergency department (A&E) at three hospitals	A TOC-DBR case study in three non-profit hospitals in the UK (Milton Keynes Hospital District, Horton Hospital, Oxfordshire and the Oxfordshire Radcliffe Hospital)	Reduction of waiting times and admissions in the departments. Additional capacity was generated without investments. The percentage of patients waiting less than 4 h in Keynes Hospital District Milton increased from 85% to 90%, and the number of patients attended per week increased to 1,200. At the Oxfordshire hospitals, the numbers increased from 50-60 to 91
Gupta and Kline (2008)	To reduce waiting times for admission in the psychiatry and therapy sectors, as well as to reduce economic impacts related to cancellation and missed appointments	A case study based on the TOC's five focusing steps was conducted in a chemical-dependency unit of a community mental health center	Through consultation reminders, the reimbursement has increased to more than \$50,000. The rate of cancellation or non-attendance fell from 43 to 20%. There was an increase in patients scheduled appointments, reduction in missed appointments and also a reduction of psychiatrist's time wasted
Stratton and Knight (2010)	To improve the patient flow in England and the Netherlands hospitals	A TOC-DBR case study application was conducted	A market constraint was identified. The patients waiting time has been reduced by 20%
Tsitaklis (2010)	To solve capacity problems, long waiting lists and low occupancy rate in hospitals	A case study based on the TOC's five focusing steps conducted in five public hospitals in Greece	The restriction was observed in the resources of the diagnostic imaging laboratory, which was causing delays and impact on the patient's transfer rate
Groop <i>et al.</i> (2010)	To support, through the TOC, the evaluation of technologies to remove or relief organizational constraints, in order to increase the transfer rate, instead of cutting costs	A TOC-based case study in a home healthcare service organization in Finland to implement a mobile solution to improve mobility	Although the conventional financial approach considered that the implementation would save time and would be beneficial, the TOC has shown that technology implementation aiming at an improvement of productivity would bring adverse effects. The restriction of the system was the distribution of workload. Leveling the workload would result in serving more customers and improvement of productivity
Mabin <i>et al.</i> (2011)	To improve the satisfaction of patients in a hospital pharmacy. The subject of the research was a leading supplier of secondary	TP-TOC and tools have been applied, with focus on EC diagrams	Reduction in the waiting time of patients, workload and overtime reduction, increased satisfaction of patients and improvement of the team morale and people retention

(continued)

Table II.

Authors	Objective	Method	Results
Group (2012)	health services in the North Island of New Zealand To explore the mechanisms and practices that inhibit the ability of home healthcare service providers to make better use of available resources, and to provide general models of solving these problems	A TOC-based case study on the Espoo Home Care (EHC), a publicly funded healthcare organization located in Finland	TOC can provide a systematic structure for identifying and addressing the factors that limit productivity. The application of TOC in-home care reveals various policies and practices that, intuitively might seem logical and efficient, but in fact are counterproductive. As a result of the investigation, the home care unit studied was able to significantly reduce the use of outsourced labor and cost reduction was estimated at €0.5m annually
Taylor and Nayak (2012)	To determine the central problem that was causing the loss of revenue in the ED of a hospital	A case study of the application of TP-TOC and CRT, EC and FRT tools in the ED of a hospital located in Texas	The triage process was not conducted properly. As a solution, a triage team was hired to improve the use of the ED
Ren <i>et al.</i> (2013)	To demonstrate how the five focusing steps of TOC can be applied in the surgical process	A literature review on the application of the TOC's five focusing steps and its application in the process of surgeries in the West China Hospital	A higher number of surgeries, reduction of overtime and increased patient satisfaction have been obtained by eliminating the constraints in the process of surgeries
Sadat <i>et al.</i> (2013)	To verify how the TOC complies with the public health systems with respect to the definition of goals, performance measures and continuous improvement. The established goal was to increase the quality and quantity of life, both now and in the future	A system dynamics representation of the TOC's goal and performance measures for publicly traded for-profit companies. A similar model was created for publicly funded health systems, including some of the factors that affect system performance, providing a framework to apply TOC's process of ongoing improvement in publicly funded health systems	The authors created stock and patient flow diagrams to define the relationships between the TOC goals and performance indicators
Nematipour <i>et al.</i> (2014)	To describe the application of TP-TOC tools aimed at the recognition of critical issues and factors of hospital supply chain in order to understand the causal relationships between these factors	A case study applying the TP-TOC in the supply chain of five major hospitals in Tehran. The pharmaceutical industry and the distribution of medicines were analyzed through the CRT tool	The root problem was the instability in the supply chain environment of hospitals in Iran, which is located beyond the range of control and sphere of influence of chain members

(continued)

Authors	Objective	Method	Results
Pergher <i>et al.</i> (2016)	Proposes a diagnostics and improvement approach based on total quality management to apply in cancer healthcare service services systems	A case study was applied in the radiotherapy service authorization process in a large Brazilian hospital	The main results permitted the definition of a set of actions to eliminate or reduce the failure modes in healthcare service systems. In addition to that, one of the advantages of the approach proposed and applied is the identification of the root causes (RC) of the problem in flow management of patients, the undesirable effects of these causes and the prioritization of the improvement actions
Souza <i>et al.</i> (2016)	Analysis of hospital bed management the perspective of the theory of constraints (TOC) under a large, private, non-profit hospital in the Rio Grande do Sul state – Brazil	It focused on applying the Current Reality Tree (CRT) proposed by the theory of constraints to alleviate the undesirable effects (UEs) related to the low availability of hospital beds. This paper presents a study of a large Brazilian hospital that aims to improve the management of the number of hospital beds using the TOC	The theory of constraints (TOC) seeks to map and act on constraints, thereby contributing to the mitigation of waste and the root causes of undesirable effects (UEs). The number of hospital beds is a significant constraint on the operation of healthcare service systems because it receives demands from various areas and requires larger volumes to implement and maintain

Table II.

summary of the research identified in the chronological order. The table shows objectives, methods and results, as well as the TOC tools of each research. Not all the studies are totally equivalent to what is made in our study, but the table reinforces the importance of using TOC in an intrinsic, complex environment, such as healthcare service organizations.

In the healthcare service industry and in the analyzed articles, notable results of the TP–TOC application are observed. In most cases, the implementation of the TOC seeks to reduce the patient waiting times, accelerate the availability of beds and serve the largest number of patients seeking both the patients’ and the employees’ satisfaction. The DBR was adopted by Umble and Umble (2006) and Stratton and Knight (2010) in order to reduce waiting times and admission, i.e., the flow of patients in the hospital. Regarding the TP–TOC, the main tools adopted were the CRT, the EC and the FRT. The studies of Taylor and Sheffield (2002), Taylor and Churchwell (2004), Mabin *et al.* (2011) and Taylor and Nayak (2012) intended to increase revenue and reduce costs, while Sellitto (2005) and Nematipour *et al.* (2014) focused on materials and supplies management. Souza *et al.* (2016) presented a study of a large Brazilian hospital that aims to improve the management of the number of hospital beds using the TOC. Finally, Pergher *et al.* (2016) propose a diagnostics and improvement approach based on total quality management to apply in cancer healthcare service systems.

3. Methodological approach

The research method was the case study (Yin, 2003). The focus of the study was exploratory and sought field evidence on ways to improve the service quality of a philanthropic hospital through the TP–TOC. The steps for the elaboration of the research are summarized in Figure 1. The combination of internal documents and processes observation, publicized

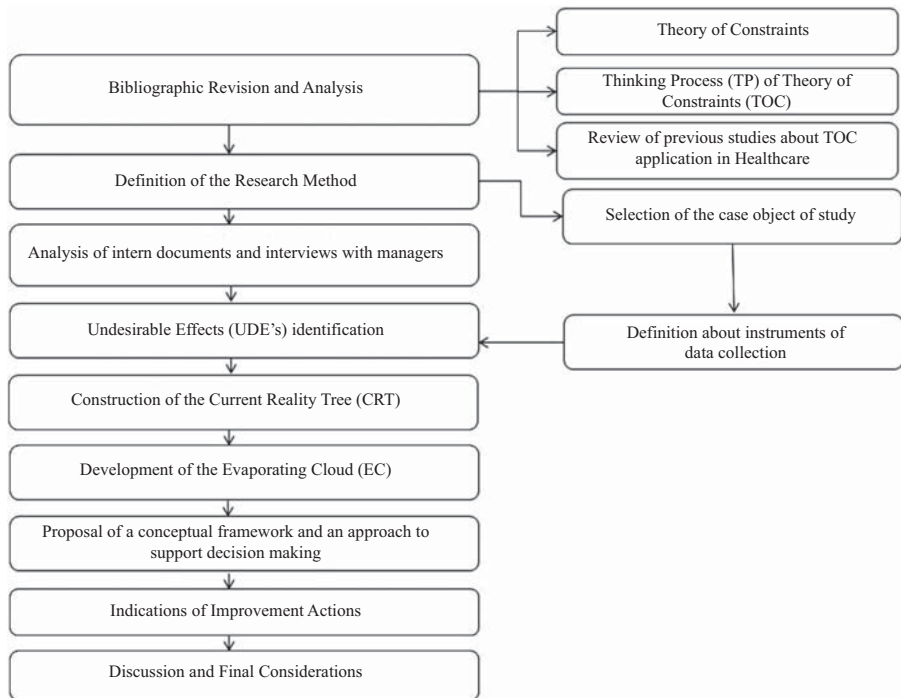


Figure 1.
Structure of research

Source: Adapted from Lacerda *et al.* (2010)

material and data gathered in interviews offered data sources for triangulation. Triangulation increases reliability and internal validity of the findings (Gibbert and Ruigrok, 2010; Sellitto, 2018).

The literature review allowed identifying the variables related to hospital services used in studies aiming the services quality improvement (Table III). Relevant studies retrieved from the extant literature provided the variables. Two experts of the hospital and two scholars reviewed and eventually completed the list.

The indicative variables of Table III helped to construct the conceptual framework of Figure 2 that systematized the study and guided the application. The framework considered both service quality and patient satisfaction as focal points for analysis. In addition, despite the proposed framework based on peer-reviewed literature, to the best of our knowledge, no previous model covering all the elements listed in Table III was found.

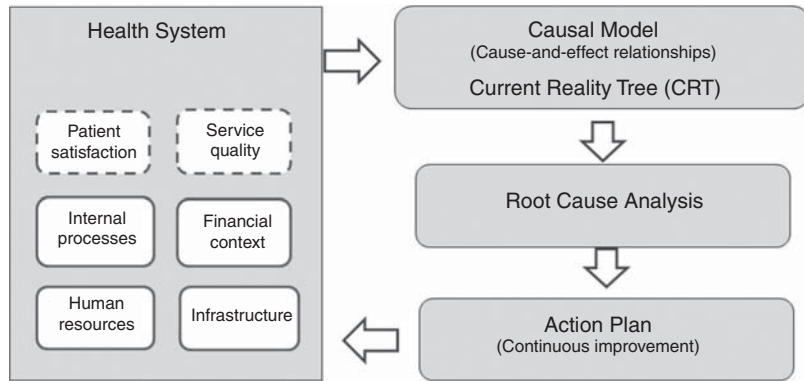
To discuss the appropriateness of the proposed framework, the case study conducted focused on the emergency department of a medium-sized philanthropic Brazilian hospital. The instruments for data collection and the research protocol were developed, and the study proposal was presented to the hospital board for approval.

Data collection was carried out between April and July 2014 and included document analysis, non-participant observation and semi-structured interviews. Interviews were based on the research constructs presented in Table III and applied to the sources presented in Table IV. The respondents were chosen based on their experience in the healthcare sector, work experience in the hospital under study, internal processes knowledge, strategic level of decision making and knowledge of the human resources internal policies.

Construct	Indicative variables	Authors
Infrastructure	Equipment for triage and diagnosis Bed needs satisfaction Suitable rooms and spaces Necessary staff Services and examinations for emergency	Ritson and Waterfield (2005), Battaglia <i>et al.</i> (2012)
Internal processes	Schedule for physicians' and nurses' activities Workforce leveling Time to admissions Length of stay Registration, triage and admission	Taylor and Nayak (2012), Groop <i>et al.</i> (2010), Umble and Umble (2006), Ritson and Waterfield (2005), Lubitsh <i>et al.</i> (2005), Lowsby <i>et al.</i> (2017)
Financial context	Financial contributions or voluntary actions for hospital activities (in countries where the public ownership dominates in healthcare sector relatively little attention is paid to the issues of financial management in hospitals) Payments related to the medical services Sources of revenue Government awareness of the need to foster and support the hospital sector	Bem <i>et al.</i> (2014), Gupta and Kline (2008), Lee (2015)
Human resources	Employees' training and qualification Team career plan Relationship and communication among employees People retention	Mabin <i>et al.</i> (2011), Taylor and Churchwell (2004), Taylor and Sheffield (2002)
Patients satisfaction	Waiting for appointments and emergency care Need to seek treatment in another city	Taylor and Nayak (2012), Lubitsh <i>et al.</i> (2005), Womack and Flowers (1999)
Service quality	Delays occurring in patient care Challenges and opportunities in services	Mabin <i>et al.</i> (2011), Kershaw (2000), Womack and Flowers (1999)

Table III.
Constructs and indicative variables associated with studies on hospital service quality

Figure 2.
Conceptual framework
related to TP-TOC in
a health system



Function	Qualification	Experiences
Head nurse	Bachelor of nursing; specialization in emergency care; emergency management; and public health; masters' degree in education	25 years of experience in hospital services and hospital management; 4 years of experience in the studied hospital
President	Bachelor in public administration; specialization in business management	Hospital's secretary from 2011 to 2013; hospital's president from November 2013 to March 2015; secretary of the hospital board from March 2015 to April 2016
CEO	Bachelor in marketing science	Experience of 10 years in the banking sector; 2 years in the studied hospital
Treasurer	Bachelor of accounting science	2 years in the studied hospital
Nurses (tree)	Technical training in nursing	Average experience from of 3 years in the studied hospital (minimum 2 years; maximum of 5 years)
Administrative assistant	Bachelor in business management	3 years' experience in the studied hospital

Table IV.
Interviewees' profile

From the interviews, the core problem was identified as the patients' dissatisfaction and the low quality of services provided by the hospital. The non-participant observation stage focused on the main processes of the SUS care system. Internal documents related to the number of attendees per specialty were analyzed, and the processes have been selected considering the relevance of the medical specialties to the hospital emergency care. The non-participant observation stage was held for two weeks, accompanying the reception, triage and nurses.

The items observed were: the physical infrastructure (general maintenance of the building, furniture, equipment and utensils); the use of equipment and supplies; the workload leveling between the teams was observed; the relationship between employees during working hours in patient care and assistance in the emergency sector; the equipment for triage; the occurrence of triage; the registration of patients; waiting times; and the internal coordination of the team in regard to the patients' care.

The CRT and EC tools were applied to the core problem. From the data collection, the research team, first, proceeded to the modeling of the CRT. The causal model generated was validated with the organization representatives (head nurse, hospital president and hospital CEO). Then, EC diagrams have been built to explicit premises and to discuss the identified conflicts. These diagrams also have been discussed and validated

with the same representatives, allowing an in-depth RC analysis. This analysis has served as a basis for the discussions about the core problem, driving the analysis to the proposition of improvement actions in the hospital. The actions were presented to the hospital board and discussed with regard to their feasibility and the resources required for their implementation.

The observations and experience arisen from the case study were then used to discuss the framework proposal presented.

4. Results and discussion

The Hospital Foundation under study has been in operation since 1983. It offers SUS services (medical assessments, glucose testing, nutritional assessment, blood pressure control) and examinations (laboratory, EGG, x-rays, scans and endoscopies) to the community. The hospital has 61 employees (25 nursing technicians, 5 people in the sanitation sector and 31 in the administrative services, including billing, chairman, director). The hospital had 52 beds and had been facing an increased demand for hospitalizations. Monthly hospitalizations rose from 78 in 2013 to 168 in 2014, on average. Despite such increase, beds were not a constraint yet. The average daily attendance in the ED had doubled, from an average of 60.3 patients in 2013 to 126.6 patients in 2014. The projection was a total amount of 45,000 medical appointments in 2014.

4.1 CRT and EC analysis

Figure 3 shows the CRT for the ED. Figure 3 embraces the logical relationships subjacent to the CRT tool. The construction of the CRT is abundantly described in the extant literature.

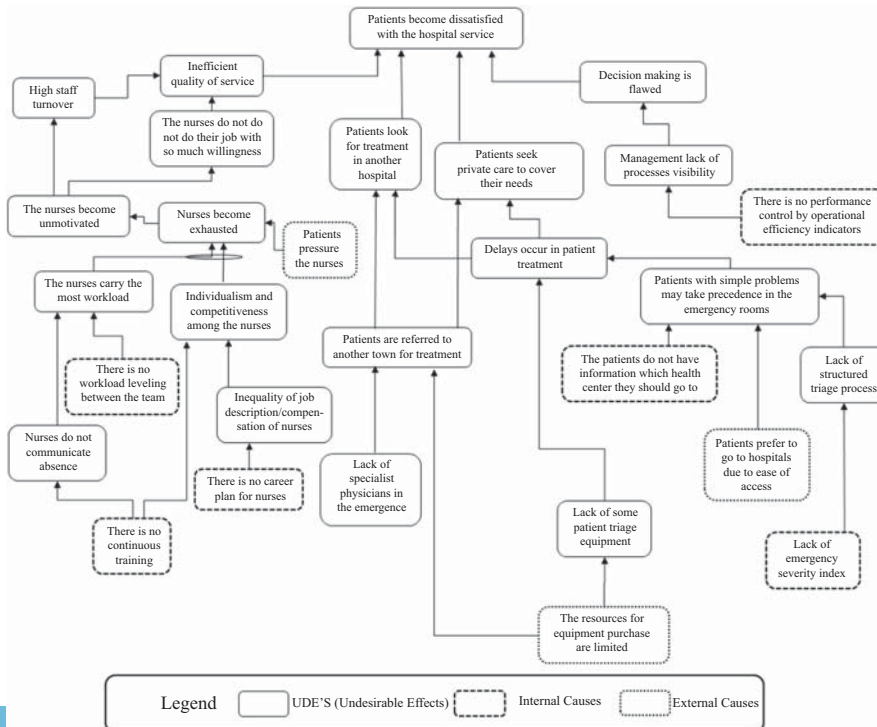


Figure 3. Current reality tree for the ED patient's dissatisfaction

Among many others, we point Kendall (2004) to further details on the construction. The CRT corresponds to the causal model of Figure 2.

Figure 3 must be followed as in the following example: if “there is no emergency severity index,” then “there is no structured triage process,” and then “patients with simple problems may take precedence in the emergency rooms.” As a consequence, “delays occur in the treatment,” leading to “patients seek to private care to cover their needs” and, as a consequence, to patients’ dissatisfaction with the hospital services and low quality.

The relationships between the causes and effects observed in the hospital lead to dividing causes into internal and external. Mainly, the limited resources and the lack of employee relationship between physicians and the hospital are external causes related to the structure of SUS. Hospitals depend on government budget to operate, and other inefficiencies in the bureaucratic system lead to delayed or poorly allocated resources. In the same sense, physicians use the facilities of the hospital, but they are considered as partners and not as employees in the system. This leads to agency problems (Jensen and William, 1976), creating an environment in which negotiation tends to prevail over hierarchy, thus leading to higher managerial complexity.

The internal causes relate to the lack of severity index for triage, the lack of demand management for specialties based on schedules, the lack of career plan for nurses, the lack of workload leveling among the teams and the lack of continuous training. These causes may be correlated to the need of professionalization in hospital management (Bornhost, 2015; Butler *et al.*, 1996; Taylor and Sheffield, 2002) or the gap still existent between hospital services and operations management (Butler *et al.*, 1996; Li *et al.*, 2002). Nevertheless, the internal RC allows us inferring that action should be taken to improve the allocation and adequate use of the workforce in the hospital, to reduce patient’s dissatisfaction with this service.

As a third category of RCs, patients lack information to choose the health center they should go look for treatment and patients prefer to go to hospitals for ease of access. These RCs have been classified separately since they represent a socio-cultural trend, effect of another systemic problem: since there is an understanding of lengthy and cumbersome public health service, patients tend to skip the level of the Basic Care Units (BCU – Unidade Básica de Saúde) for assessment, and to go directly to hospitals. Hospitals are not allowed to refuse patients, becoming hubs of excess demand. Meanwhile, the lack of information about service and occupation levels in different BCUs and hospitals reinforces such population behavior, since hospitals are seen as more prepared to attend severe cases.

From the analysis, it has become also evident that actions focused just on internal causes would mitigate, but not completely eliminate the problem of patients’ dissatisfaction. As the UEs arise independently of other causes, any of these RC may lead patients to become dissatisfied. This perception of independence of causes is coherent to the context of healthcare (Groop *et al.*, 2010).

As the hospital team was able to identify and to learn about the RC and their influence on patient satisfaction and quality services, it was possible to move to the RC and conflict analysis. The following step was to discuss how the hospital could draw up a plan to provide better service to the population based on the improvement of the processes associated with the internal roots identified.

A set of EC diagrams was built to explicit existing conflicts, in order to drive potential solutions to the hospital. For instance, it was observed the lack an adequate triage system in the ED. To implement such system the hospital must train the team and invest in equipment and infrastructure. However, this requires investment in both personnel training and equipment. The conflict arises since the hospital does not have resources to do so (Figure 4).

Figure 4 depicts the EC tool to find the RC (or core problem) of the ill-defined situation. As for the CRT, the extant literature abundantly describes the construction of the tool. The EC corresponds to the causal analysis of Figure 2.

As a plan of action, in the short term, it is suggested that the hospital develops a career plan, as well as staff training, influencing their turnover rate. In addition, training should only be provided to those employees with in-depth knowledge of the processes, with minimum two-year company time. In the medium term, information should be provided to the public so that they are aware of available services, and locations other than the hospital to seek a diagnosis. Also in the triage process, the hospital can adopt a color system. In addition, in terms of long-term investments in equipment can be made according to the perspective of receiving and reimbursing funds at federal, state and municipal levels.

While external factors become more difficult to manage by the hospital, such as federal, state and municipal government resources for the acquisition of equipment and expansion of physical facilities. However, it is suggested to start-up funds from private entities and the development of campaigns encouraging spontaneous contribution from the population, also new ways of thinking public–private partnerships projects in healthcare service can contribute to attendance improvement.

4.2 Discussion

SUS is a complex system (Paim *et al.*, 2011; PWC, 2013). It consists of a series of interdependent units that complement each other and seek to meet the population health needs. The system evolved from previous national health policies, aiming at increased efficiency. Nevertheless, it still falls short on its objectives due to factors such as the identified as external in this study.

Information to the population is a key aspect: many citizens do not know if they should either look for a BCU, an Emergency Care Unit (ECU) or a hospital ED. In 2003, the Brazilian Ministry of Health created the ECU program to integrate emergency care and to reduce waiting times in hospitals (Ministério do Planejamento, 2017). Nevertheless, no adequate orientation was disseminating to the population. As a consequence, hospitals receive a significant amount of cases that could be attended in BCUs distributed across the neighborhoods. Intermediate-severity cases could be transferred from BCUs or directly taken to ECUs, which act as hubs for BHUs (Ministério do Planejamento, 2017; Portal Brasil, 2011) allowing hospitals to care about their core focus: acute cases, and elective treatment. In other words, part of patients' dissatisfaction is related to the misunderstood use of SUS: many people end up in hospitals because there is full (excess) care, instead of being directed to seek neighborhood health workers as soon as a health condition appears.

There are other contextual elements that contribute to patient dissatisfaction. The health sector experiences problems originated from the public health management process. Despite the tax exemptions received by the Hospital Foundation, as a philanthropic institution, the amount the government reimburses the hospitals does not cover the costs of consultations and procedures. This entails the Foundation's deficit, which tends to generate long-term concerns about investment and interferes with the service quality provided to the patient.

In the hospital under analysis, the triage process was not well structured and required changes, as well as the training of personnel involved in this process. Such fact is similar to

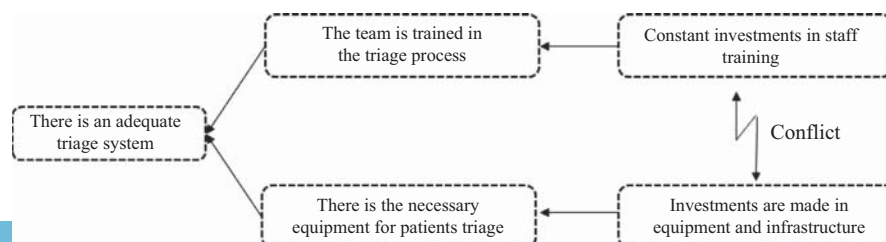


Figure 4.
 Evaporating cloud
 diagram for the lack
 of adequate triage
 system

that found by Taylor and Nayak (2012), in the emergency department of a Texas hospital. In addition, it is at the ED that patients' expectations regarding staff communication with patients wait times, the triage process, capacity and payment will determine a significant part of a hospital's revenue (Taylor and Nayak, 2012).

The triage is as an essential first step in efficient and effective emergency care (Lowsby *et al.*, 2017). The introduction of a risk classification in health centers, hospitals and outpatient clinics can ease the burden of emergency and emergency services (Groop *et al.*, 2010; Taylor and Nayak, 2012). Patients can be redirected to other providers such as clinics, urgent and/or private care centers. Lowsby *et al.* (2017) suggest the use of colored categories triage systems since they ensure that patients with greater acuity are prioritized after screening evaluation. Once patients are seen by a healthcare service provider, a decision is usually made quickly with regard to greater management, i.e., discharge or admission.

The improvement of several processes, such as the screening system and the communication, has a direct impact on patient care, as observed by Groop *et al.* (2010). Training and qualification can improve the workload leveling, which would result in serving more patients and improving productivity. These effects could also contribute to reducing, in the specific case of the studied service, the nurse's overload and the staff turnover.

The development of a careers and salaries plan was also identified as relevant. For the physicians, the SUS remuneration table is perceived as low-payment, leading newly graduates do not want to work on the ED. For the nurses and technicians, the possibility of foreseen career progression is also perceived as a motivational aspect.

Overall, implications drawn from this study are:

- The implementation of the TP-TOC was relevant for the hospital staff and managers, agreeing with the stated by Goldratt (1990) and Reid and Cormier (2003). In any organization, there are professionals with conflicting goals, as evidenced in this study. The operational tools allowed to give attention and to combine the opinions of those involved, revealing, in a constructive manner, the hospital current reality and the root problems associated with the patients' dissatisfaction. The collaborative and friendly approach enabled those involved to explain their perceptions about the working atmosphere, forming a consistent and plural view of the encountered problems (Goldratt, 1990).
- The incorporation of procedures in a systematic way as proposed in the framework has allowed improving the decision making and action planning (Reid and Cormier, 2003; Taylor and Churchwell, 2004). In the specific context, it is possible to conduct an in-depth analysis of the system and its relationships before any intervention being performed.
- In a broader sense, it was evidenced by the participants the possibility of applying the TP-TOC approach as an operational support in the preparation of certain stages of the strategic planning, allowing the verification of the strengths and weaknesses of the hospital processes through the CRT and the other tools. It was possible to identify to which processes the actions should be directed to so that there would be a greater gain to the hospital as a whole. This view agrees with the presented by Cox and Spencer (1999).

In short, while the potential for applying the approach of this paper is observed, a lack of operational mechanisms that allow tactical and strategic troubleshooting in health service environments is inferred. This perception is coherent to that stated by Bornhost (2015) and Butler *et al.* (1996). Although based on a single study carried out, the perception detected from the participants' reports is that, at least regionally, there is room for improvement of

the planning and decision-making processes by means of this and other approaches of operations management. This argument echoes also on the perception of mimetic isomorphism found in hospital and care systems (Bornhost, 2015; Souza *et al.*, 2016).

5. Final remarks

The aim of this study was to propose an approach based on the TP–TOC to support decision-makers, managers and professionals of health to diagnose and improve healthcare systems focusing on the service quality deployed to patients. A case study was developed in a SUS-affiliated philanthropic hospital in southern Brazil, through the analysis of its ED processes application of the TP–TOC. The TOC–TPC framework generated the application of the CRT and EC tools that supported the construction of an action plan and the analysis of its implications on the service, providing a connectivity along the steps of the study.

Data were triangulated from different sources to provide evidence on how UEs are perceived and combined to generate patients' dissatisfaction. Delays in patients' treatment, exhausted and unmotivated nurses and lack of adequate triage are examples of identified problems. Root problems related to internal management were the lack of a workload leveling between the team, lack of a program of employees' continuous training, lack of a career plan for nurses and the lack of an emergency severity index. External RC also have been identified and discussed, as limited resources for equipment purchase, lack of information to patients choose the health center they should go to look for treatment.

The proposed approach allowed the hospital team to progress in the understanding of such causes in a sequential manner, giving conditions to apport different perceptions and to identify relevant facets and causes related to the problem besides the commonly referred (such as lack of resources and excess bureaucracy). In the context of the study, developing a structured method for screening patients as an emergency severity index is essential. In addition, it was suggested to develop a system to prioritize some consultations with experts, and demand management based on schedules that do not follow the logic "first to mark will be the first to be scheduled." As patients do not know which health center they should go to according to symptoms, the city should create information plans to direct patients to BCUs and ECUs, disclosing to the population when each provider should be sought for assistance.

From the perspective of the hospital management, the results of this research generate evidence that can be confronted with research or similar contexts, and it can provide support for the better use of resources. However, the TOC is an ongoing process and not an appropriate and permanent solution to a particular situation (Lin, 2009). It is important to consider changes in business environments. It cannot be generalized that a particular TOC application will result in a gain for other similar philanthropic institutions.

As a suggestion for further research in the light of the TP–TOC, comparisons of the costs incurred through the activity-based costing or throughput accounting and similar applications in the healthcare sector could be made. Also, the framework proposed in this work should be further analyzed and applied. Studies on bed management, surgical centers and image diagnostic centers could provide evidence for testing and refine the proposed approach.

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