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APPLYING PROBLEM STRUCTURING METHODS FOR THE MANAGEMENT OF INFRASTRUCTURE PROJECTS IN UNIVERSITIES

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ABSTRACT. Brazilian public universities are essential entities to foment technological and scientific development through the generation and transmission of knowledge; the existence of this environment is only possible through the capture, maintenance, and management of organizational resources. Ensuring the availability of such resources is a complex process. Regarding the management of infrastructure projects, the scenario is especially challenging. Considering this context, the main purpose of this article is to apply a multimethodology, based on Strategic Options Development and Analysis (SODA) and Soft Systems Methodology (SSM), to structure the problem of managing infrastructure projects in a Brazilian Public University, using data collected in a previous analysis to explore the perspective of key stakeholders. The decision-making relevant system was chosen to be detailed and explored. Results show that the proposed multimethodology was able to provide essential diagnosis for the decision situation, bringing three main levels of necessary facilitating intervention.

Keywords: SODA, SSM, university infrastructure.

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1 INTRODUCTION

Brazilian public universities are essential entities to promote knowledge generation and transmission, thus stimulating and training individuals to enhance the country's technological and scientific development (Oliveira, Mendes & Torezzan, 2019). The existence of this environment is only possible through the capture, maintenance and management of organizational resources from all natures (e.g. material, human, and financial). Ensuring the availability of such resources is not a simple process. With regard to entrepreneurships management, such challenges become especially complex.

The inherent complexity that permeates this environment can be explained by aspects such as the existence of units, departments, and/or groups of individuals (e.g. deans, directors, and professors) which may present conflicting interests; the lack of objectivism in the decision making process; the coexistence of different activities in the campus such as teaching, research and extension; legal limitations; decentralized decision-making council; and severe resource limitations (Esteves, 2013; Oliveira *et al.*, 2019).

Considering this scenario, evaluating ways of structuring the problem of managing infrastructure projects in Brazilian public universities, aiming to promote a healthier, more suitable and more useful environment for its members, is an important proposal. The literature presents some studies that address the issue of public projects management in the university environment and related issues, but the implementation of problem structuring methods for this purpose is little explored.

Esteves (2013) evaluated the management of the design process and physical space within public universities; through the systematization of processes and information flows, and the identification of the main problems associated with this context, the author was able to provide a diagnosis of the maturity level of the planning and management processes of these institutions and give proper recommendations for the development of projects in public universities (Esteves, 2013).

Bittencourt, Ferreira and Brito (2017) applied a descriptive case study to evaluate the process of implementation of public projects in federal universities, by studying a support program for restructuring and expansion plans of Federal Universities, aiming to identify the main factors and constraints that resulted in the completion, delay, or stoppage of the infrastructure projects in the federal educational institutions (Bittencourt *et al.*, 2017).

Oliveira *et al*. (2019) proposed a multicriteria approach to decision aiding in the management of entrepreneurships in Public Universities, aiming to support the decision-making process by strengthening the planning and execution of projects through the incorporation of diverse strategic interests of the institution (Oliveira *et al*., 2019).

Given the opportunity to explore the application of problem structuring methods, the present work aims to structure the problem of managing infrastructure projects in a Brazilian Public University, using data collected in a previous analysis to explore the perspective of key stakeholders. To achieve this objective, a multimethodology was applied, based on Strategic Options Development and Analysis (SODA) and Soft Systems Methodology (SSM). The article is structured as follows: Session 2 presents a literature review, Session 3 presents the methodology, Session 4 presents the results, and Session 5 presents the conclusion.

2 LITERATURE REVIEW

Problem structuring methods (PSMs) can be defined as a class of qualitative modeling approaches, which are part of the soft operational research field (Ackermann, 2012; Smith & Shaw, 2019). Such methods emerged individually from the 1960s (Mingers & Rosenhead, 2004), but the existence of an area dedicated to the study of PSMs, as an alternative to overcome certain limitations observed in the application of quantitative methods of operational research (OR), is attributed to the late 1970s and early 1980s (Ackermann, 2012).

The limitations of operational research based on quantitative methods, also called hard OR, reside mainly in the fact that such methods lack greater flexibility to absorb complex contexts, characterized by the existence of multiple actors, different perspectives, partially conflicting interests, significant intangibles, and perplexing uncertainties, as defined by Rosenhead (2006). The relevance of such factors can be different depending on the situation, so distinct PSMs can be applied to provide analytical assistance within each complex context (Rosenhead, 2006).

Considering the particularities of each problem situation, different problem structuring methods have already been described and applied in the literature, e.g., to develop multi methodologies and/or structure specific problems (Georgiou & Heck, 2021; Munro & Mingers, 2002). Georgiou and Heck (2021) provided an overview of four PSMs until their consolidation in 1989, investigating aspects such as the number of publications and citations links, having as its main contribution the creation of a bibliographic atlas of the theoretical development of such PSMs, being them: Robustness Analysis (RA); Strategic Choice Approach (SCA); Strategic Options Development and Analysis (SODA); and Soft Systems Methodology (SSM) (Georgiou & Heck, 2021).

According to Smith and Shawn (2019), SSM, SCA and SODA are methods widely explored in the literature about PSMs; in comparison, RA, like Drama Theory, are less representative, as investigated by Munro and Mingers (2002). Belton and Stewart (2010) confirm the dominance of SSM, SCA and SODA, and attribute this incidence to the fact that such methods are more generally applicable, as they can be used to expose ideas and structure thoughts about a given subject; on the other hand, Robustness Analysis focuses particularly on the consideration of uncertainties about the future, while Drama Theory covers the tensions that may arise in contexts of cooperation or conflict between various agents. Concerning SODA, this method was initially developed by Colin Eden and colleagues, and considers a cognitive mapping approach as its main tool: a graphical representation (in a map format) is constructed by a person or a group to represent a problematic situation, in order to explore options and develop consciousness towards some aspects of the problem that were not seen before, taking into account a complex system of goals or objectives (Abuabara & Paucar-Caceres, 2021; Ackermann, 2012; Georgiou, 2010). This mapping approach allows the comprehension of the point of view, perspective, and sense of reality that constitute the problem situation for a stakeholder individually, but the context as a whole is conceived as the sum of recognized information from all the involved parties (Abuabara & Paucar-Caceres, 2021).

The cognitive mapping used by SODA is based on the concept of personal constructs, developed by George Kelly. A construct can be described as a dichotomously composed of two poles, which represents two contrastant or alternative ideas used to minimize ambiguity: once language is capable of absorbing different connotations and interpretations, an alternative pole can improve the understanding of a primary pole, reducing its subjectivity (Abuabara & Paucar-Caceres, 2021; Georgiou, 2010).

Manso, Suterio & Belderrain (2015) used SODA to map out Sao Paulo state's disaster management system. This PSM was able to provide a detailed analysis towards the problem context and dynamics, enabling the identification of the main aspects that should be treated to reduce the obstacles that hamper effective disaster management, such as the absence of processes and procedures between all the stakeholders, and poor coordination.

Hjortsø (2004) used a modified version of SODA to engage citizens participation in a strategic forest management planning process. Results show that the PSM was able to promote a much more active role for the stakeholders, in comparison with traditional public participation activities. Among other things, SODA was able to generate some improvements such as a higher stakeholder's involvement perception, enhanced transparency in the decision process, and higher quality and quantity of stakeholders inputs to the planning process.

Guanieri, Silva and Levino (2016) used SODA to analyze electronic waste reverse logistics decisions in Brazil. The PSM application allowed the identification of the key aspects that must be improved in order to provide an effective implementation of the reverse logistics networks for electronic waste, such as the installation of collection points of e-waste in retail channels, the creation of government policies related to tax incentives, and the reduction of environmental impact.

Georgiou (2019) applied SODA to map railway development prospects in Brazil, using published articles from a Brazilian railway industry's magazine as the raw material of his research. The articles comprehended the perception of recognized authorities in the Brazilian railway industry (e.g. engineers and consultants) regarding an issue. Considering the fact that perceptions are cognitives views of a situation, cognitive mapping was chosen as a logical approach to be followed, and it was proved to be helpful to highlight causes and consequences of certain decisions reported in the articles. However, a few methodological improvements were suggested by the author, such as to consider causal dynamics in order to better predict the magnitude of an effect (e.g., degrees of track system deterioration, which change over time) (Georgiou, 2009).

It is important to notice that the use of a cognitive mapping approach to structure complex situations is not limited to the application of PSMs such as SODA. The Fuzzy Cognitive Map (FCM) is a technique that represents the causal reasoning between ideas by means of fuzzy-graph structures, which allows the definition of hazy degrees of causality between concepts (Axelrod, 1976;

Kosko, 1986); this technique was applied e.g., by Schramm *et al.* (2020), who developed an approach based on FCM to assist the water management and planning committee, presenting it as a powerful tool for supporting the decision making within this context; The Fuzzy Logic was also studied by Giordano *et al*. (2007), who proposed its integration with Problem Structuring Methods to support the design of a monitoring system for water management, a proposal to be further implemented in three case studies.

However, as described in the Individuality Corollary, one of the eleven corollaries in which the Personal Construct Theory was formulated by George Kelly (Kelly, 2017), it is unlikely that any two persons would ever create identical systems, as their construction of events is different. In addition, the Sociality Corollary also describes that the decision makers must find a common way to both construe events, and define options to reach consensus (Reynolds & Holwell, 2020), which is specially relevant for a group dynamics.

Considering this context, a Causal Map – a composition that arises from the grouping/amalgamation of Cognitive Maps – must present a level of consensus, which might be harder to achieve if not only the description of events and options is required, but also the degree of causality. Given that, the application of FCM or Fuzzy Logic based approaches may attribute an additional complexity to the process, which must be balanced with the methodology potential return to ratify its feasibility to a particular context.

Concerning SSM, it was developed by Checkland, and the first paper detailing the story of its development was published in 1972 (Checkland & Winter, 2006). SSM is based on a practical/theoretical approach that considers both elements derived from experiences in real-world problem situations and literary background of social theory (Checkland & Winter, 2006). It can be interpreted as "a process of inquiry and action for improving unstructured problem situations where the issues of concern are vaguely perceived but not clearly defined" (Coelho, Antunes & Martins, 2010).

The application of SSM can be summarized in seven stages, as described in Figure 1 (adapted from Neves, Martins, Antunes & Dias, 2004). It is important to notice that the identification and conceptualization of relevant systems commence at explicitly state perspectives or world views (Bunch, 2003).

In general, SSM application starts with the comprehension of a situation rather than a specific problem; in order to do so, its context must be fully understood and appreciated, considering social, political, and cultural aspects. Once this context is examined and comprehended, a cartoon-like representation of the problem situation is made, aiming to reveal e.g., processes, relations, agents, structures, or other important aspects of the context. This representation, applied in the second step of SCM, is called "rich picture", and it is notably relevant to understand the current situation and raise potential concerns (Ackermann, 2012).

Regarding the root definition step, it aims to produce a condensed statement about the system. In order to do so, the CATWOE mnemonic can be applied to assure that the main elements are considered, as follows: "C" stands for Customers, defined as the beneficiary or victims of the

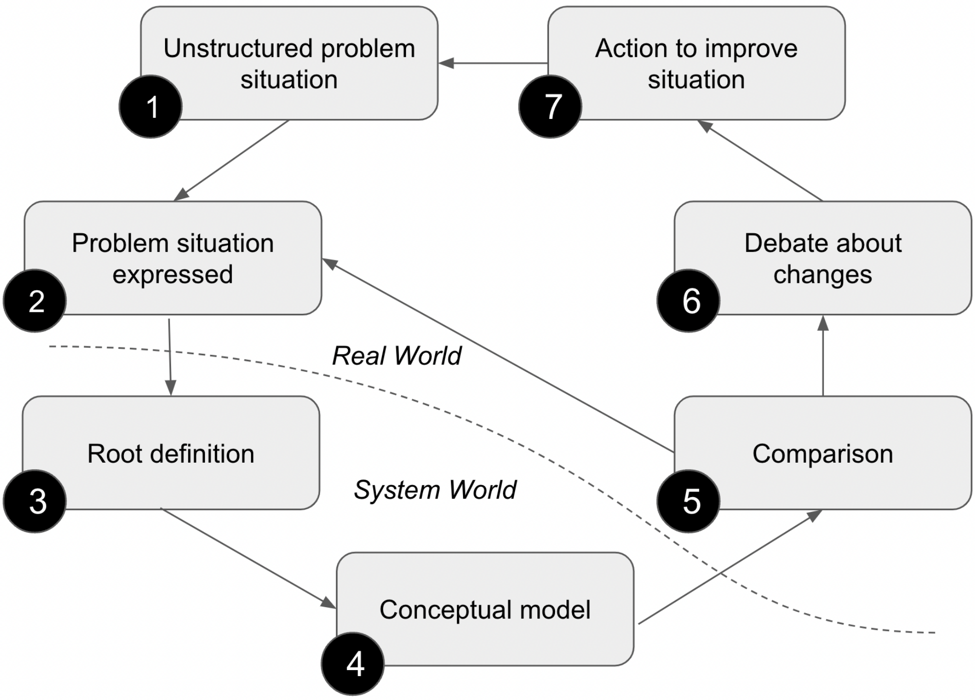

Figure 1 – SSM application stages.

Adapted from Neves *et al.*, 2004.

system's activity; "A" stands for Actors, defined as the people who will perform the Transformation process (T), which can be described as the activity to be modeled, traditionally represented by a transformation process - an input converted into an output; "W" stands for Weltanschauung, and represents the worldview and beliefs that enables the transformation to be meaningful; "O" stands for Owner, defined as the people who could stop the Transformation, represented in the majority of the reported studies by those with the formal power to do so; and finally, "E" stands for Environmental constraints, which represents the elements outside the system which it takes as given (Checkland and Tsouvalis, 1997; Bergvall-Kåreborn *et. al*, 2004).

Neves *et al.* (2004) used SSM to rethink the analysis of energy efficiency initiatives. The authors concluded that the PSM was able to provide a fresh view of the context, helping to structure problematic issues to be faced by the different agents involved in the situation. Moreover, SSM was also important for identifying stakeholders and their relations, enabling the modeling of an evaluation system that could replace the pure quantitative approach, which is based on a cost-benefit analysis, and seems to be inadequate for evaluating energy efficiency initiatives (Neves *et al.*, 2004).

Coelho *et al.* (2010) used an SSM-based approach for structuring decision support in urban energy planning, aiming to use it as a first step for the development of MCDA tools. The defined approach enabled the authors to characterize the decision problem context as accurately as possible, identifying the main stakeholders, their relations, and important aspects for each one of them, taking into account their individual interests and preferences (Coelho *et al.*, 2010).

Considering the context of the management of infrastructure projects in a university environment, a PSM application has not been found in the literature. However, as described by Oliveira *et al.*, (2019), the management of public facilities is a complex issue that encompasses several challenges (Stacey, 2016 as cited in Oliveira *et al.*, 2019); in the specific case of public universities, these challenges involve e.g., limited budgets, lack of prioritization, and decentralized decision-making mechanisms, reinforcing the suitability of this context as viable for the application of PSMs.

3 METHODOLOGY

The studied university, as well as other Brazilian academic environments, had a problematic history with the management of infrastructure projects, bringing serious consequences, such as paralyzed projects, paid projects that were not executed, and a long lead time for the process as a whole. In order to face this situation, a team was established to conduct a strategic project that would propose a new model for the management of university infrastructure projects. This job was carried out during the period of 2017 and 2018, and had a problem structuring phase, which used the following tools: project team brainstorming meetings, semi-structured interviews with units and research centers directors, work process mapping techniques, and benchmarking with similar size entities to understand how they did the management of infrastructure projects.

The job also contemplated a thorough investigation of 150 processual documents related to seven infrastructure projects of different departments and/or campi from the same university, as well as meetings with its main stakeholders (Projects Department, Campus Town Hall, Central Administrative Department, Economic and Financial Planning Department, Language Studies Institute, Arts Institute, University Technical College, as well as a projects company). These infrastructure projects encompass different maturity stages: already finished, ongoing, postponed or without a resumption forecast.

A set of documents were generated as a result of this previous analysis, which consists of: meeting notes from discussions focused on some specific topics regarding the problem situation (e.g., financial resources and supervision), benchmarking registers of other public institutions, and a final report detailing the context, history, main issues and current status of each infrastructure work studied, among some relevant data such as the general estimated costs for the execution of projects, and the average distribution of bids or projects per area. All documents were analyzed to capture and translate stakeholders' perceptions of the problem situation.

Considering this context, the present research applied a multimethodology approach which adopts the records of the previous problem structuring work described above as its raw material, in a similar approach to Georgio (2009), who also used records as inputs for his analysis. In view of the context complexity, it is essential to have a clear vision of the current scenario and its main issues, in order to find improvement opportunities that can generate impact for one or more stakeholders. Considering that the rich picture, from SSM, is an excellent tool to understand the agents involved in the problem situation, its relations, interests, behavior and impact on the general context, it was chosen as part of the methodology.

Moreover, given the fact that a cognitive mapping approach can highlight an individual point of view towards a problem situation, explaining the variables that exist in his/her sense of reality, the construction of cognitive maps for main stakeholders, from SODA, was also chosen as part of the present methodology. To develop both the rich picture and the cognitive maps, stakeholder information collected in the previous research cited above was consulted, resulting in the multimethodology approach described in Figure 2, and detailed as follows.

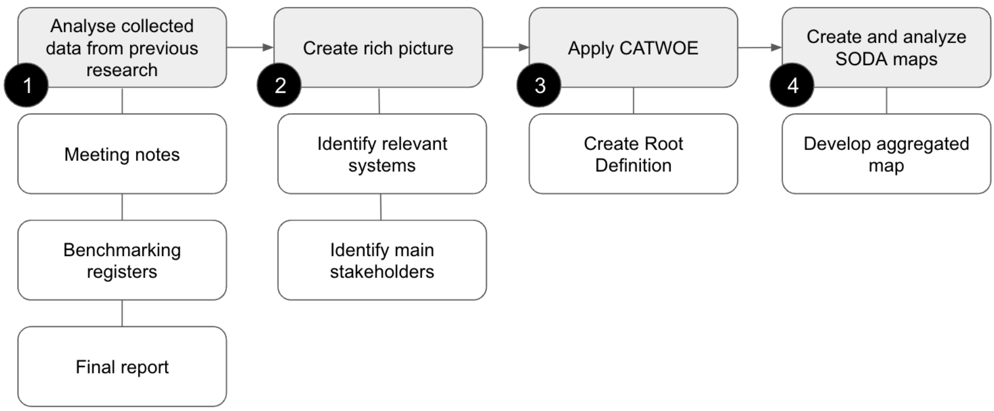

Figure 2 – Methodological framework.

Concerning the rich picture creation step, some guidelines were used to facilitate its comprehension, as follows: (1) speech bubbles were used to express potential dialogues or requests that could exist in the given context; (2) a color coding was used to highlight the speech bubbles from different stakeholders (e.g., blue for students and red for researchers); (3) the relations between agents were represented by arrows, starting from the executor; in the case where an input was represented, the arrow started at the input.

In addition, the representation was based on the records of the tools and/or strategies application outcomes present in the previous study and cited in Session 3 (e.g., notes from the semi-structured interviews with units and research centers directors). Regarding the cognitive map creation step, given the amount of information to be explored in step one, in order to better organize the reasoning structure, the collected data was first analyzed individually for each stakeholder, and then aggregated in a causal map.

4 RESULTS

As shown in Figure 3, on the top of the rich picture, the four different scenarios of infrastructure projects that coexist in the university environment are represented: unfinished projects, in progress constructions, finished constructions, and construction projects in inappropriate locations, which may be finished or unfinished. These four scenarios represent part of the complexity towards the problem, since all these construction projects should be monitored, inspected, and registered, what does not happen in the current context. One of the problems arising from this is the fact that the maintenance group is not involved in the early stage of construction projects development, being only called when the situation is already critical.

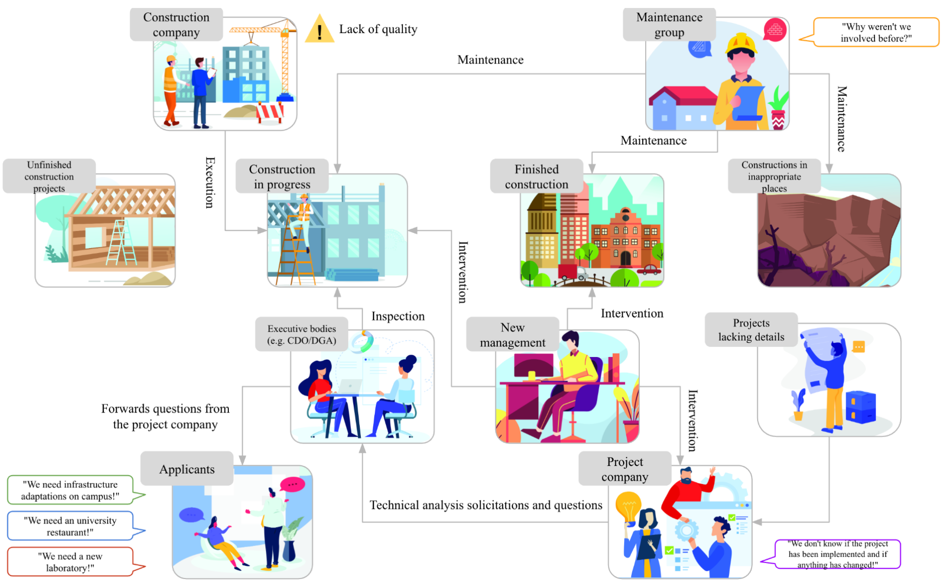

Figure 3 – Management of infrastructure projects in the University, June 2022.

At the bottom of the figure, different stakeholders are represented, as well as some issues regarding each one of them, as described below:

- Project company: receives the contract in an "umbrella" format, with many project demands together, but without important details and/or information, which require them to contact executive bodies to better understand the requirements. Moreover, the project company usually does not receive any feedback about the project evolution: e.g., if it was actually implemented, if it is under construction, if some modification was implemented, and so on.

- Executive bodies: Represent the university's executive teams, whether they are administrative, responsible for contracting and administratively managing project hires and construction execution, or technical, overseeing the technical aspects of project development and construction within the university. These stakeholders are generally overloaded with many technical analysis solicitations, which may result in delays. Moreover, they are not fully integrated in the whole process, but act as a bridge between the project or construction company and the applicants.

- University maintenance team: They need to address maintenance issues in systems that are often cost-effective during its implementation, but present significant maintenance challenges. As they are generally excluded from the decision-making, buildings become potential maintenance hurdles. This team consists of in-house labor and a contracted company under a continuous service agreement (facilities). In the problem structuring process ahead, this team will be grouped with the executive bodies, as both of them are directly affected by the whole process.
- Applicants: in general, necessities from applicants are different and come from unrelated departments, which is another aggravating factor that makes it difficult to manage the construction projects. In addition, most of the time, applicants do not have access to the project company directly and are not aware of the construction status, once there is no report or system to check its evolution, which may require them to go physically to the construction place if needed.

Moreover, another stakeholder group is represented, which is the construction companies, highlighting the fact that many times it lacks quality, which may generate some negative impacts such as: construction scheduling delays, and unplanned corrective maintenance needs. New management agents are also represented (such as a change of Rector), to highlight the fact that sometimes political interferences may exist, impacting different parts of the process, e.g., modifying projects and undergoing constructions, and/or allocating another department to a building that was not built for this purpose.

From Figure 3, we can see at least 3 relevant systems in this disarranged scenario: (i) the operational system, represented by the inter relations between the maintenance group, executive bodies and construction companies; (ii) the budget planning and execution, represented by the management, construction company, project company, applicants and executive bodies; and (iii) the decision-making process, which is the most important in our vision, represented by the governance structure between the applicants, the executive bodies, and the management representatives. With a pulverized decision-making mechanism, based on autonomous collegiate bodies that have to deal with the challenge to coordinate distinct interests and scarce resources, the decision-making process represents a great challenge for improvements in this scenario. Given that, despite the existence of several relevant systems, this work will focus on the decision-making process, considering the following characteristics:

(i) lack of well defined criteria: with the absence of criteria, the decision for an infrastructure project execution is based on political arrangements. This point brings uncertainty into the issue, as it is not clear which demand is a priority, and the pressure on the technical teams ends up defining which work will be carried out first;

(ii) lack of budget definition for each demand: the registers mention that the budgets were not previously defined, as the decision-makers did not have clear notions about the costs involved in each demand. In other words, as the financial constraints did not allow to construct the entire building, partial executions were permitted, resulting in a large list of paralyzed projects, paid projects that will not be executed, and empty buildings without furniture, data and/or telephone networks - consequently, not using their full potential;

(iii) absence of a structured decision-making process: without a workflow to demand a construction or a retrofit, clients can demand their projects at the rectory, university council, technical areas, etc., resulting in a disarranged situation, to the extent that it would not be possible to clearly predict the demands in the execution queue, imposing operational and financial problems.

4.1 Stakeholders' definition for the decision-making process.

The main stakeholders for this relevant system can be clearly identified in the documentation adopted as input, as listed below:

- Applicants: (i) research project leaders: the demands are a consequence of research projects and teaching objectives, in most cases. Despite being very interested in the scenario, they have little power in the process; (ii) teaching and research unit leaders: they are the managers and political sponsors in the universitary units, and usually have influence in the political scenario. In most cases they are the applicants too; (iii) employees: these stakeholders represent the group that is interested in this issue, but do not deal directly with it; and (iv) students: in most cases, they are the final investment purpose, and through their representation entities, present claims for improvements that bring demands for projects with them.
- Management - Rector: is the maximum authority, and his/her opinion must be considered all the time. If the Rector does not agree with the solutions listed, they have smaller chances of thriving. A change in this position may lead to unplanned interventions, such as an alteration of project scope and priority.
- Executive Bodies and maintenance team: these officials' work is directly affected by the whole process, and most of the improvement solutions (or even correction, in the case of maintenance) must be implemented by them, so their opinion is extremely important for the structuring process.

4.2 CATWOE Analysis and Root definition

Considering the selected relevant system and its main stakeholders described in the previous sessions, a clear Root Definition of the decision making process was made using the CATWOE mnemonic, as described below.

- C - Customers: the applicants (e.g., students, professors, researchers);

- A - Actors: executive bodies;
- T - Transformation process: the need for a structured decision-making process for the management of infrastructure projects in the university, converted into the need met
- W - Weltanschauung: structure the decision-making process is desirable to improve its efficiency and optimize its costs;
- O - Owners: the University Rector; University Council;
- E - Environmental constraints: strict law code, budget availability for all resources needed (e.g., machinery, material and workforce).

Given the CATWOE elements, the Root Definition is: a structured, efficient and optimized decision-making process for executive bodies to manage infrastructure projects in the university environment, in accordance with the rectory guidelines, and available budget.

4.3 The SODA map for the relevant system

Considering the focus on the decision-making relevant system, Figure 4 shows the aggregated SODA map, which was created based on the analysis of the documents described in Session 3 and on the CATWOE application. From the analysis of both the Rich Picture and the SODA map, it can be noticed that it is clearly important for the selected relevant system that the institutions' projects are linked with the university's strategic objectives.

From the analysis of Figure 4, one single cluster is identified, and the dominance of each construct is described in Figure 5(a) and detailed as follows.

Figure 5(a) shows that construct 8 can be considered a relevant aspect to the map, once it is the dominant construct. Moreover, from the analysis of both Figure 4 and Figure 5(a), from dominance D=4, constructs 7 and 9 are important causes in the map, once the amount of out connections (dout) is superior to the amount of in (din) connections (in both constructs, dout = 3 and din = 1); while constructs 3 and 5 are important effects in the map, once the amount of out connections is inferior to the amount of in connections (in both constructs, dout = 1 and din = 3)

Moreover, argument lines can be identified in the map, represented by the sequence of connected constructs. The argument line shows itself as a proper tool for representing the stakeholders' pains in the process. All argument lines for the selected relevant system are described in Figure 5(b). For example, in the 'arg2' line, the argument line can be described as "a construction demand is requested and there is no evaluation about the impacts at the end-activity or reputation, there is no evaluation about necessary projects for the institution and, finally, it is not known if the demand is a priority for the institution".

Considering the structure described by Figure 5, and taking a closer look into Figure 4, it can be seen that the constructs that identify the choices after a work is requested look to evaluate technical (related to risk to people and property, represented by construct 7), financial (related to

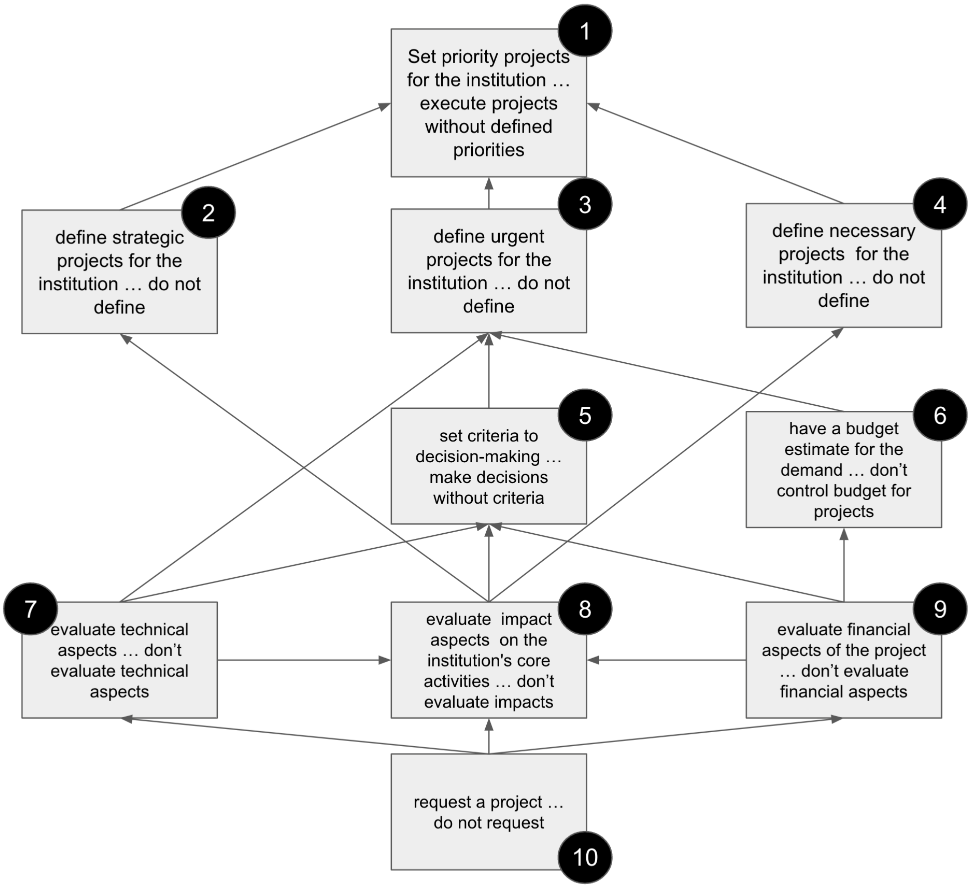

Figure 4 – Aggregated SODA map for relevant system.

(a)

Dominance	Amount of constructs	Constructs
D=1	0	-
D=2	3	2,4,6
D=3	2	1,10
D=4	4	3,5,7,9
D=5	0	-
D=6	1	8
Total	10	

(b)

Argument lines	
arg1	10, 8, 5, 3, 1
arg2	10, 8, 4, 1
arg3	10, 8, 2, 1
arg4	10, 7, 8, 5, 3, 1
arg5	10, 7, 5, 3, 1
arg6	10, 7, 3, 1
arg7	10, 9, 8, 5, 3, 1
arg8	10, 9, 5, 3,1
arg9	10, 9, 6, 3, 1

Figure 5 – Constructs dominance and argument lines presented in the SODA map.

estimated investment involved, represented by construct 9), and impact (related to end-activity and reputation for the institution, represented by construct 8) aspects that main stakeholders, according to the project documentation, consider to be relevant criteria for this issue.

Once these initial aspects have been evaluated, the second level of constructs can be viewed, and it is related to the criteria setting for decision-making (construct 5) and the budget definition for projects in execution at the time (construct 6). It is important to highlight that even though budget limitation is an environmental constraint, the more knowledge the university has about the estimated budget, the more coherent and effective the budget planning will be.

The second level of constructs point to another level that has three different aspects represented by constructs related to strategic issues (construct 2), urgent priorities (construct 3), and necessary demands that have to be executed in a defined order (construct 4).

The top-level construct for this relevant system is related to the decision-making output (construct 1), that can be represented by a set of priority infrastructure projects that must be executed, considering that they are strongly related to the strategic objectives, weighted by urgency and budget evaluations.

A careful look at the map structure brings three major situations that can be considered, and these situations are coincident with the identified levels above: in a lower level, the method brings that the institution has to define how the technical, financial and impact aspects will be measured. In an intermediate level, the method shows that a set of criteria that are important for decision making must be defined, along with how the institution will estimate the investment budget.

Going forward, the method gives the top level (construct 1), which is related to how the institution will evaluate its demands for infrastructure projects, taking into account the aspects listed in the previous constructs. According to the SODA approach, the three strategic options that should be treated by decision-makers are the constructs directly linked to this head construct, being them: construct 2, 3, and 4.

The analysis implies that the use of Multicriteria Decision Aiding can be a valuable additional tool for the structured problem, once it can help in selecting which projects and/or aspect(s) should be prioritized considering the listed strategic options (strategy, urgency, and necessity).

From these results, it is notable that the gaps of the complex scenario and its improvements opportunities are clearer, offering a proper support to drive initiatives that should be implemented to solve the problem.

5 CONCLUSION

Analyzing the results from the application of the proposed methodological framework, it can be concluded that, for the addressed situation, it seems adequate for structuring the disarranged situation that encompasses the management of infrastructure projects. The rich picture and the SODA map brought valuable results for understanding both the relevant systems and the main stakeholders involved in this context.

In addition, the proposed methodology seems adequate to reconstruct the problem structuring process, once it was able to bring up essential diagnosis for the decision situation: the analysis of construct dominance highlighted some important potential causes of the problem situation (e.g., the lack of financial evaluation in a request), and some relevant effects (e.g., criteria setting for decision making process) that should be considered to propose an effective action plan to improve the current scenario.

Moreover, the three main levels of necessary facilitating intervention became clear in the SODA map, and provided some relevant insights that could address the issues represented by the Rich Picture. For example, the initial level, formed by the evaluations about technical, financial, and impact aspects can be improved e.g., by establishing a workflow that allows the technicians to evaluate the demands.

Now, the second level, which refers to defining a set of criteria to prioritize the demand and estimating its budget, can be done e.g., by selecting the main relevant characteristics and its respective weights in a group session with the stakeholders. On the third level, the structuring considering priority, emergency, and necessity can be done with, e.g., the use of a Multicriteria Decision Aiding/Analysis method.

It is important to highlight that regardless of the proposed improvement(s), it must be aligned with the University Rector and the University Council, once they have the power to stop the transformation, as described by the CATWOE analysis.

As future developments arising from this paper, we can extend the proposed framework for the remaining systems identified, which can bring up other evaluations from the model. Another possibility concerns applying the methodology in a real-time situation, allowing the use of different tools for the diagnosis, such as group dynamics, and data treatment. Moreover, the application of Fuzzy Cognitive Maps instead of SODA might also be investigated, as to compare both methodologies in terms of implementation effort versus return in the context of problem structuring.

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