

Analysis of the Process of Public Bids for Works and Engineering Services

Daniela Matschulat Ely¹, Rogério Cabral de Azevedo², Antônio Edésio Jungles³

^{1,2}Centro Federal de Educação Tecnológica de Minas Gerais

³Universidade Federal de Santa Catarina

(¹daniela.ely@gmail.com, ²cabral.razevedo@gmail.com, ³ajungles@gmail.com)

Abstract- Not all activities that are performed to obtain the product are necessary to the process and can be classified as "activities that do not add value". In the quest for continuous process improvement, it is necessary to be aware of the activities that are vital to the realization of a product. One way to obtain this knowledge, it is to carry out process mapping. The objective of this research is to analyze the public bidding process of engineering works and services to provide managers with data for the search of continuous improvement. For this, a case study was carried out. In it, it was executed the mapping of the process and the analysis of the activities that compose it, as to its value aggregation. The research has shown that the process is managed in a fragmented way and that there is a significant portion of activities that do not add value/"no-value-adding activities" in the process. The justification of the classification of all the activities allowed to conclude that it is not always necessary a big financial investment to improve the process. Another point identified was the need for an actor that manage the process in a systemic way.

Keywords - Public Works, Bidding, Process Mapping

I. INTRODUCTION

The procurement of public works and engineering services for construction is carried out by a bidding process. The bids have a sequence of procedures ranging from the identification of the need for the work or service to the accountability of the work or service performed [11].

These procedures are characterized by a process composed of several stages, where several public and private agents are involved. When the public work is understood as a process, it is possible for each agent involved to have a responsibility and, consequently, to be charged by it [8].

Due to the characteristics of public works construction in Brazil, the stages of the bidding process occur in a fragmented way. This means that there is no efficiency-oriented management system at the construction site, increasing the chance of errors, rework, cost increment, additive request, and project success compromise [2]. Thus, in order to achieve effective public management, it is necessary to improve the process of resource allocation, in order to achieve institutional objectives [3].

To understand the fragmentation of the bidding process for public works and engineering services, the use of the process flow mapping technique is proposed. By doing so, the activities of the process can be known and classified based on their added-value to the process. With this information it is possible to carry out a diagnosis of the process, for improvement propositions based on actual data.

II. PROCESS MAPPING

Process can be defined as a set of systematic activities performed to achieve a final result [9]. To manage a process, you must first see it. The visualization can be made through its mapping. With the mapping, the process can be represented by a flowchart, which shows the various activities required and the sequence of this activities for the assembly of a product [7].

With process mapping, the goal is to obtain answers to questions such as "What to produce?", "How to produce?", "How much to produce?", "When to produce?", "To whom to produce? etc. [4]. It allows those involved to have an overview of the process, with a distinction of actors' activities and responsibilities [3].

Process mapping is a tool that makes it feasible for the complete visualization of a process. It enables the understanding of the activities carried out in it and its dependency relations. Through its use, it becomes simpler to determine where and how a process can be improved [4].

When analyzing a process one must observe the perspectives of both internal customers and external clients, so that their needs can be met. Another important point it is the search for each activity of the process to add value to the product. If this does not happen, a waste will be happening [10].

This technique, in addition to helping to characterize the process, has the intent of assisting in the identification of waste for its consequent reduction / elimination. For this, activities should be classified based on the potential of adding value to the product. Activities can be classified as [6]:

- activities that add value: those that convert material and / or information into what is required by the customer;

- activities that do not add value: they are those that take time, resources or space, but that do not add value. These can also be called wasteful. There are activities that do not add value, but are necessary to the process, such as training.

III. METHODOLOGY

The process mapping is aimed at identifying the sequence of execution, the activities to prepare projects for bidding, the place where each activity is developed (organization's sector) and the human resources involved. Based on this information, this research proposes the classification of the activities, as described in [6].

The execution of the process mapping and classification of activities follows the steps of Fig. 1. The first step deals with the preparation for the data collection. In it, a theoretical revision is made, where scientific research works and laws are investigated. The review seeks to describe the bidding processes for public works and engineering services. With this, it will be possible to know the main activities of this type of process, which helps to structure spreadsheets for data collection.

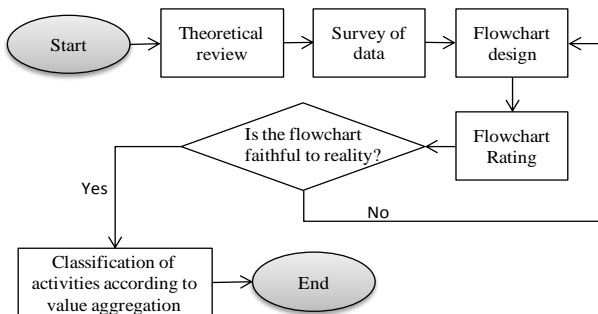


Figure 1. Steps for process analysis

The data collection aims to obtain the information necessary for the design of the process of the case study. The information can be collected through a semi-structured interview, document analysis and / or computerized system data analysis. The data can be raised with the actors involved in the process of the product development. These actors are the people who act directly in the development of the activities of the process within the public organization.

Data collection is limited to activities carried out by the public organization. As for the processes of private organizations, the model is limited to mapping the public-private interface, not analyzing the processes carried out by private organizations. This is because the focus of the research is to improve the management of public processes and not in private organizations.

With the data collected, the design of the process flow diagram should be performed. It is nothing more than the graphical representation of the process flow, which transforms the information collected into a visual element. This allows the

process to be understood more easily. The mapping should be performed using the symbols of ISO 5807-1985 (Tab. 1) [4].

TABLE I. SYMBOLS OF FLOWCHART

Symbol	Meaning	Symbol	Meaning
	Terminator		Process
	Decision		On page connector

Fonte: [5]

After its preparation, the flowchart of the process must be evaluated in order to eliminate possible distortions. This evaluation should be done through interviews with the actors of the process studied. In the interviews, the drawing flowchart is showed to verify whether there are any distortion. If there are distortions, the flowchart must be changed to create a new flowchart version. This evaluation process must be repeated until there are no further distortions

When the flowchart of the process does not present any distortions, it is possible to perform the classification of activities based on their aggregation of value. In this way, the activities are differentiated according to their usefulness for the bidding process of public works and engineering services. In the classification of activities it is recommended that the justification for the classification of each activity be documented. Thus managers can identify why certain activities do not add value and seek for a continuous improvement based on actual data.

IV. RESULTS

The theoretical review showed that public biddings for Brazilian engineering works or services have large well defined stages, as can be seen in Figure 2.

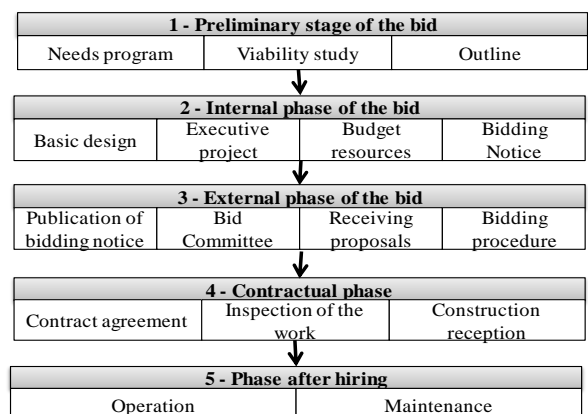


Figure 2. Phases of the execution of public bidding and engineering services. Source: [1]

The case study covered only part of the case. The part studied covers the arrival of the demand (needs program), until the reference term is realized. The process flow mapping of the

case study can be seen in Fig. 3. The activities described in the process map were summarized so that the visualization of the

process flow was facilitated. The activities are grouped into subproducts of the process.

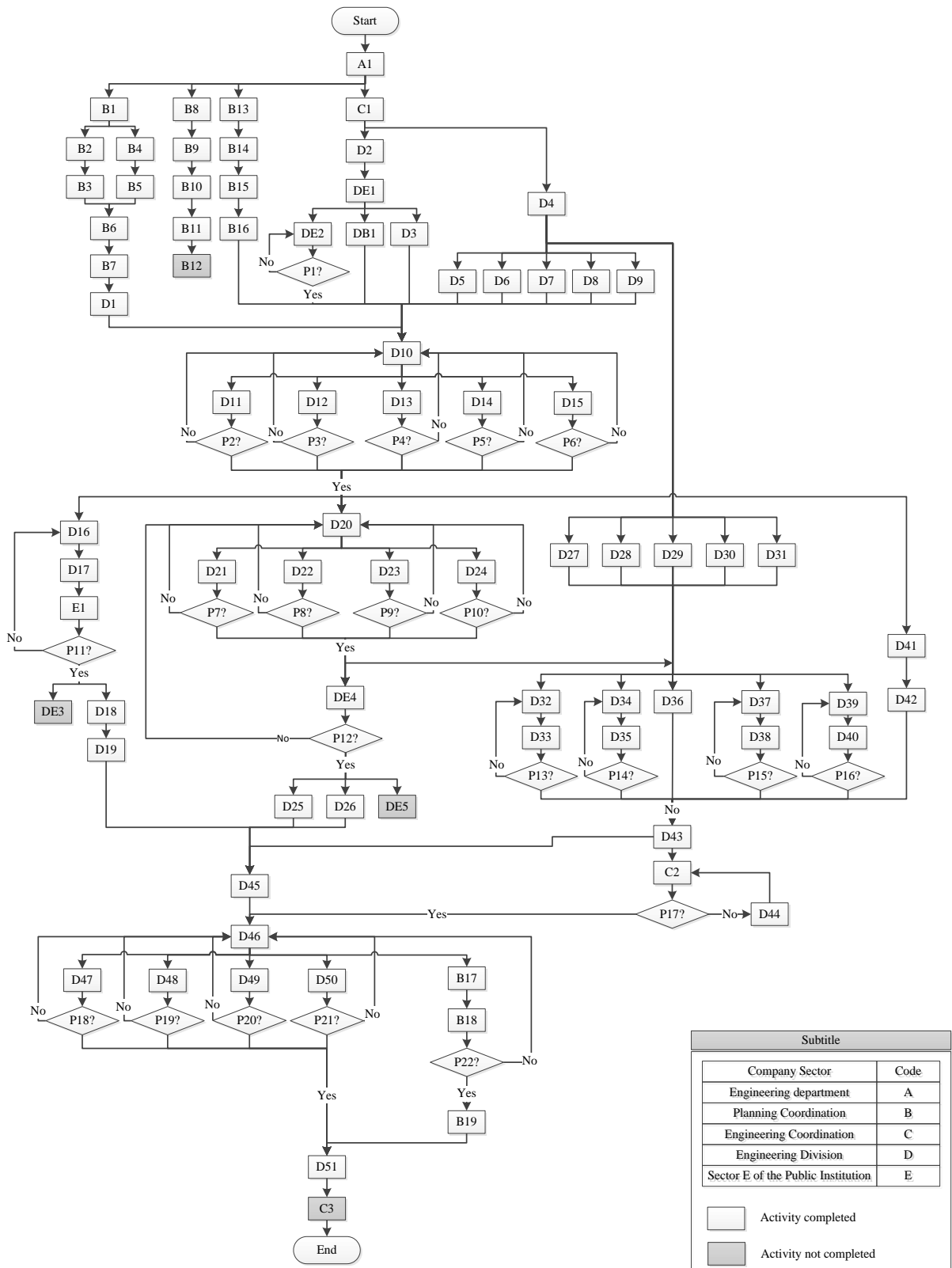


Figure 3. Project process flow of the Public Institution and Sector

The meanings of the codes present in Fig. 3 can be seen in Tab. III (Appendix I). It is possible to observe the description of the activity, the sector of the actor (s) responsible for the elaboration of the by-product and the name of the developed by-product.

For the formulation of the process' map it was necessary to design more than ten versions of the flowchart. This happened because in the realization of the flow chart evaluation, the actors remembered new activities. This demonstrated that the actors, although they knew the main flow of the process, they were not aware of it at the operational level.

For the elaboration of the first versions of the process' map, the actors who were at higher hierarchical levels were interviewed, since they had a more systemic view of the operation of the process. Subsequently, the other actors were also interviewed.

When the flowchart showed no further distortions, the activities were listed and ranked based on their potential to add value to the product. Their classification and their justifications can be seen in Tab. III of Appendix I.

Table II shows the percentage of activities, by type of classification, by subproduct. In it, one can observe the proportion of the activities between the types of classification in each by-product. The by-product that has the highest percentage of activities that do not add value is the "descriptive memorial", in which 83.33% of its activities are classified in this way. The by-product "feasibility study of electrical infrastructure" has the lowest percentage of activities that add value, with 12.50%. The highest percentage of activities that add value happens in the "justification" byproduct (66.67%).

TABLE II. PERCENTAGE OF ACTIVITIES BY RANGE OF CLASSIFICATION REGARDING THE AGGREGATION OF VALUE BY SUBPRODUCT

Subproduct	Do not add value	Does not add value, but is required	Add value
Electrical infrastructure Feasibility study	50,00%	37,50%	12,50%
Environmental feasibility study	20,00%	60,00%	20,00%
Preliminary study	44,44%	11,11%	44,44%
Urban feasibility study	25,00%	50,00%	25,00%
Architectural design	44,44%	22,22%	33,33%
Descriptive memorial	83,33%	0,00%	16,67%
Justification memorial	33,33%	0,00%	66,67%
Needs program	33,33%	16,67%	50,00%
Reference term	81,82%	0,00%	18,18%

These percentages can help the manager identify which by-products need to be improved first. This choice should seek to eliminate activities that "do not add value," and reduce activities that "do not add value, but are necessary." These cuts/eliminations can cause some actions to be required, such as training the actors so that review activities can be eliminated.

In addition, these percentages can be used for comparison with other processes. For the process that does not have the same by-products, Fig. 4 shows the relationship between the types of classification of the activities of generic form. It is possible to observe that only 36.59% of the activities of the process "add value to the product" and that most of the activities "do not add value", that is, it is unnecessary.

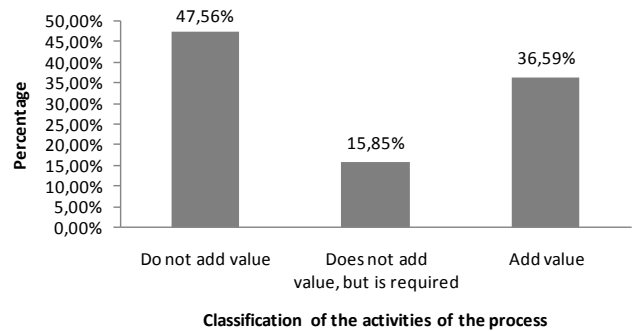


Figure 4. Percentage of activities per added-value classification range

Activities that "do not add value, but are necessary" should be carefully studied. Its elimination should not be taken to the extreme, because even though they do not transform the product some are necessary for the process to occur.

When analyzing the activities that comprise the process of Sector E, the Public Institution, it is necessary to have an actor who acts as general coordinator of the process. It should integrate the by-products and define whichactors are responsible for performing the by-product activities. Thus, some activities that do not add value can be easily eliminated. Transparency in determining the actors responsible for each activity helps control the resources involved.

V. CONCLUSIONS

As the theoretical revision was carried out, which had the purpose of understandingthe bidding processes of public works and engineering services, it was noticed that the process had already been described in other publications. The prior knowledge of the stages of the process facilitated the collection of data for the design of the flowchart of the studied process. Thus, in interviewing the actors, the interviewer already had a notion of the stages of development of the of public bidding process for works or engineering services.

The case study enabled the practical knowledge of activities that are part of a process of preparation for the bidding of projects. In general, the research found in the theoretical review that described this type of process does not present the detail of the activities at the operational level. This research can show in detail the process' activities at an operational level in the process mapping. The analysis and dissemination of these details are important so that the actors from different organizations can also learn from the

experiences of others. In this way, this research provides information for the practice of benchmarking.

The flowchart design of the process proved to be crucial in order to properly analyze the process in the search for continuous improvement. Its drawing should be checked so that all activities are correctly represented as well as their dependency relationships. Forgetting an activity causes it not to be evaluated and its poor performance is not corrected, damaging the rest of the process.

It is recommended that the flowchart of the process begins to be assembled based on the interviews performed with the higher hierarchical actors. These actors probably have a more systemic view of the activities required to produce the product. The interview with actors with lower hierarchy should only generate, if necessary, minor modifications.

The case study showed that 47.56% of the activities of the process "do not add value". This result shows that the process has great opportunities for improvement. These enhancements can improve resource optimization and shorten its lead time.

The understanding of the activities' relationship and the percentage of the ones that do not add value indicates that one of the problems of public bidding processes for engineering works and services is found in the legislation that guides it. Legislation induces the process to be managed in a fragmented way.

Evidence of this fragmented management can be observed when analyzing the causes of the classification these activities as "activities that do not add value". It is perceived that the improvement of the process often involves small changes in the activities, which in general do not demand great amount of financial resources.

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APPENDIX I

TABLE III. COMPLEMENTATION OF PROCESS FLOWCHART INFORMATION

CODE	Description of activities	Classification of activities	Justification	Product
A1 ¹	Order of service to carry out preliminary project	Does not add value, but is required	Necessary, because the actors need to know that they must develop the project.	Order of Service
B1	Order of service to carry out the feasibility study of electrical infrastructure	Do not add value	An order has already been issued. If it were communicated to all the actors involved, it would not have to happen more than once.	EIFS
B2	Request for information about future installation demands	Does not add value, but is required	To carry out a project it is important to know the demands that the new building will have and its existing infrastructure. Therefore, although it does not effectively transform the product, it is important to obtain the information so that the sizing is carried out according to the need.	EIFS
B3	Forwarding information about the future installation	Does not add value, but is required		EIFS
B4	Survey of existing electric projects in the land	Does not add value, but is required		EIFS
B5	Visit to the site of the future installation	Do not add value	If the plants were correctly updated, both the organization and the external organ would not be necessary.	EIFS
B6	Elaboration and submission of the feasibility study of electrical infrastructure	Add value	This activity materializes the by-product of feasibility study of electrical infrastructure and makes the process flow.	EIFS
B7	Forwarding/Submission the feasibility study of electrical infrastructure	Do not add value	The study could be directed by actor 5 in activity B6 to his supervisor (actor 2) and to the other actors who need it, if the process flow and responsibilities were clearly established from the beginning of the project. This would prevent the performance of this activity without disrespecting the hierarchy of functions.	EIFS
D1	Forwarding/Submission the feasibility study of electrical infrastructure	Do not add value		EIFS
B8	Order of service to carry out the environmental feasibility study	Do not add value	An order has already been issued. If it were communicated to all the actors involved, it would not have to happen more than once.	EFS
B9	Visit to the site of the future installation	Does not add value, but is required	The purpose of this visit was to verify the existence of a sewage collection system. If the ground plants were properly upgraded, this visit would not be necessary either in the organization or in an external organ.	EFS
B10	Consulting of environmental feasibility with external authorities agencies.	Does not add value, but is required	Necessary to have knowledge about the current situation of the sewage collection network.	EFS
B11	Environmental feasibility study	Add value	This activity materializes the byproduct of environmental feasibility study for consultation with in external agencies.	EFS
B12 ²	Forwarding/Submission the environmental feasibility study	Does not add value, but is required	Although not transforming the product, this activity causes the process to flow.	EFS
B13	Order of service to carry out the urban feasibility study	Do not add value	An order has already been issued. If it were communicated to all the actors involved it would not have to happen more than once.	UFS
B14	Visit to the site of the future installation	Does not add value, but is required	Its purpose was to observe the current situation of the land, observing among other things the vegetation of the place. With it, it was possible to perceive the best location within the land for the future installation.	UFS
B15	Consultating of urban feasibility with external bodies	Does not add value, but is required	Necessary to have knowledge about the zoning situation of the region, because the master plan had just changed.	UFS
B16	Elaboration and forwarding/submission of the urban feasibility study	Add value	This activity materializes the byproduct of urban feasibility study and makes the process flow.	UFS
C1	Order of service for preliminary study	Do not add value	An order has already been issued. If it were communicated to all the actors involved, it would not have to happen more than once.	PS
D2	Order of service for preliminary study	Do not add value		PS
DE1	Meeting to request fulfillment of request book	Does not add value, but is required	It aimed at making the end user fill out a form that stated their needs. It is based on this information that the required documents are based.	PS
DE2	Filling of the request book	Add value	This activity materializes the needs of the end users of the future installation.	PS

¹ Activity not considered in the evaluation.

² Activity not completed during data collection.

DB1	Beginning of the preparation of the preliminary architectural study	Add value	Beginning of the development of the preliminary architectural study, even without all the necessary information.	PS
D3	Preliminary communication of the program of needs	Does not add value, but is required	Pass on the first information collected by filling the request book so that those responsible for studying the needs of the complementary projects can begin their activities.	PS
D4	Order of service so that project team makes the study of the needs of the complementary projects	Do not add value	An order has already been issued. If it were communicated to all the actors involved, it would not have to happen more than once.	PS
D5	Study and forwarding/submission of lighting and force design needs	Add value	This activity materializes the needs of the projects regarding the area of lighting and strength.	PS
D6	Study and forwarding/submission of the needs of mechanical designs	Add value	This activity materializes the needs of the projects regarding the mechanical area of.	PS
D7	Study and forwarding/submission of the needs of the hydrosanitary and preventive project against civil fire	Add value	This activity materializes the needs of the projects regarding the area of sanitation and prevention against civil fire.	PS
D8	Study and forwarding/submission of structural project needs	Add value	This activity materializes the needs of the projects regarding the structural area.	PS
D9	Study and forwarding/submission of the needs of preventive projects against fire, structured cabling and property security	Agrega valor	This activity materializes the needs of the projects regarding the areas of fire prevention, structured cabling and property security.	PS
D10	Elaboration and forwarding/submission of the preliminary architectural study	Add value	Final materialization of the preliminary architectural study.	PS
D11	Analysis of the preliminary architectural study on lighting and power projects	Do not add value	To verify if past instructions have been followed in the development of the preliminary architectural study. The ideal is that this verification does not have to be performed and in order for this to happens, it is necessary that the actors are trained to convey clearly and understand the necessary information without the need for rework.	PS
D12	Analysis of the preliminary architectural study of mechanical designs	Do not add value		PS
D13	Analysis of the preliminary architectural study for the projects sanitary and preventive against fire	Do not add value		PS
D14	Analysis of the preliminary architectural study regarding the structural design	Do not add value		PS
D15	Analysis of the preliminary architectural study regarding the fire preventive, structured cabling and patrimonial security projects	Do not add value		PS
D16	Beginning of the elaboration of the program of needs	Add value	Beginning of the formalization of the development of the program of needs. It is fed by the information collected in the preliminary study. It starts even if you do not have all the necessary information.	NP
D17	Elaboration and referral of the program of needs	Add value	Finalization of the preparation of the program of needs.	NP
E1	Revision of the program of needs	Does not add value, but is required	Although, it is a review activity, it is necessary, because since the user does not have technical knowledge about project development, he may have difficulty transmitting the needs.	NP
DE3 ³	Program of needs subscription	Add value	This activity makes the program of needs legal.	NP
D18	Forwarding/Submission of the Program of needs	Do not add value	The ideal would be to not have to make revisions. If this were true, this activity would not have to exist.	NP
D19	Review and forwarding/submission of the needs program	Do not add value	The ideal is that this verification does not have to be performed and for this it is necessary that the actors are trained to convey clearly and understand the necessary information without the need for rework.	NP
D20	Elaboration and forwarding/submission of the architectural draft for review regarding complementary projects	Add value	This activity materializes the byproduct of architectural infrastructure design and makes the process flow.	AD
D21	Revision and forwarding/submission of the architectural design plan for lighting and power projects	Do not add value	The ideal is that this verification does not have to be performed and for this it is necessary that the actors are trained to convey clearly and understand the necessary information without the need for rework.	AD
D22	Revision and forwarding/submission of the architectural design plan for mechanical designs	Do not add value		AD
D23	Revision and forwarding/submission of the architectural draft in relation to hydrosanitary and preventive projects against fire	Do not add value		AD

³ Activity not completed during data collection.

D24	Revision and forwarding/submission of the architectural draft in the fire prevention, structured cabling and property security projects	Do not add value		AD
DE4	Meeting to review the draft with users	Does not add value, but is required	Although it is a review activity, it is necessary, because since the user does not have technical knowledge about project development, he may have difficulty transmitting their needs.	AD
D25	Elaboration and forwarding/submission of technical responsibility report of the architectural draft	Agrega valor	This activity makes the architectural draft legal.	AD
D26	Forwarding/Submission of the final architectural draft	Does not add value, but is required	Although not transforming the product, this activity causes the process to flow.	AD
DE5 ⁴	Signature of the architectural draft	Add value	This activity makes the acceptance of the architectural draft legal by the user.	AD
D27	Beginning of the development of the justification memorial and document of contribution for elaboration of the term of reference for the projects of illumination and force	Add value	Beginning of the formalization of the justification memorial. It makes it possible to legalize the needs of complementary projects. It starts even if you do not have all the necessary information.	JM
D28	Beginning of the development of the justification memorial and document of contribution for elaboration of the term of reference for the mechanical projects	Add value		JM
D29	Beginning of the development of the justification memorial and document of contribution for elaboration of the term of reference for the hydrosanitary and preventive projects against civil fire	Add value		JM
D30	Beginning of the development of the justification memorial and document of contribution for elaboration of the term of reference regarding the structural projects	Add value		JM
D31	Beginning of the development of the justification memorial and document of contribution for elaboration of the term of reference regarding preventive projects against fire, structured cabling and property security	Add value		JM
D32	Development and forwarding/submission of the justification memorial and document of contribution for elaboration of the term of reference for the projects of illumination and force	Add value	Formalization of the development of the justification memorial. It makes it possible to legalize the needs of complementary projects.	JM
D33	Revision of the justification regarding lighting and force projects	Do not add value	The ideal is that this verification does not have to be performed and for this it is necessary that the actors are trained to convey clearly and understand the necessary information without the need for rework.	JM
D34	Development and forwarding/submission of the justification memorial and document of contribution for elaboration of the term of reference for the mechanical projects	Add value	Formalization of the development of the justification memorial. It makes it possible to legalize the needs of complementary projects.	JM
D35	Revision of the justification for mechanical designs	Do not add value	The ideal is that this verification does not have to be performed and for this it is necessary that the actors are trained to convey clearly and understand the necessary information without the need for rework.	JM
D36	Development and forwarding/submission of the justification document and contribution document for elaboration of the reference term for the sanitary and preventive projects against civil fire	Add value	Formalization of the development of the justification memorial. It makes it possible to legalize the needs of complementary projects.	JM
D37	Development and forwarding/submission of the justification memorial and document of contribution for elaboration of the term of reference regarding the structural projects	Add value		JM
D38	Revision of the justification for structural projects	Do not add value	The ideal is that this verification does not have to be performed and for this it is necessary that the actors are trained to convey clearly and understand the necessary information without the need for rework.	JM

⁴ Activity not completed during data collection.

D39	Development and forwarding/submission of the justification document and contribution document for the elaboration of the term of reference regarding the preventive projects against fire, structured cabling and patrimonial security	Add value	Formalization of the development of the justification memorial. It makes it possible to legalize the needs of complementary projects.	JM
D40	Revision of the justification of the preventive projects against fire, structured cabling and patrimonial security	Add value	The ideal is that this verification does not have to be performed and for this it is necessary that the actors are trained to transmit clearly and to understand the necessary information, without the necessity of reworking.	JM
D41	Development and forwarding/submission of the descriptive memorial	Add value	Formalization of the development of the descriptive memorial. It makes it possible to legalize the needs of the architectural project.	DM
D42	Review of descriptive memorial	Do not add value	The ideal is that this verification does not have to be performed and for this it is necessary that the actors are trained to convey clearly and understand the necessary information without the need for rework.	DM
D43	Unification and forwarding/submission of justificatory memorials	Do not add value	The justificatory memorials have already been forwarded once. Ideally, the responsible actors in each area should direct them to the subsequent activity that adds or not value, but it is needed. To respect the hierarchy they should be sent to the immediate boss and subsequent activity.	DM
C2	Review of justificatory and descriptive memorials	Do not add value	The ideal is that this verification does not have to be performed and for this it is necessary that the actors are trained to convey clearly and understand the necessary information without the need for rework.	DM JM
D44	Review of descriptive memo	Do not add value		DM
D45	Beginning of the elaboration of the draft of the term of reference	Add value	Beginning of the formalization of the development of draft of the term of reference. It starts even if you do not have all the necessary information.	RT
D46	Elaboration and forwarding/submission of the draft of the term of reference	Add value	Formalization of the development of the draft of the term of reference. It starts even if you do not have all the necessary information.	RT
D47	Review and forwarding/submission of the draft of the reference term for lighting and force projects	Do not add value	The ideal is that this verification does not have to be performed and for this it is necessary that the actors are trained to convey clearly and understand the necessary information without the need for rework.	RT
D48	Review and forwarding/submission of the draft of the reference term for mechanical designs	Do not add value		RT
D49	Review and forwarding/submission of the draft term of reference for structural design	Do not add value		RT
D50	Review and forwarding/submission of the draft of the reference term for preventive projects against fire, structured cabling and property security	Do not add value		RT
B17	Order of service for revision of the draft of the term of reference	Do not add value	The ideal would be to not have to make revisions. If this were true, this activity would not have to exist.	RT
B18	Review and forwarding/submission of the draft of the reference term regarding urban viability	Do not add value	The ideal is that this verification does not have to be performed and for this it is necessary that the actors are trained to convey clearly and understand the necessary information without the need for rework.	RT
B19	Forwarding/Submission of the draft term of reference for urban mobility	Do not add value	The ideal would be to not have to make revisions. If this were true, this activity would not have to exist.	RT
D51	Forwarding/Submission of the draft of the reference term for review	Do not add value		RT
C3	Review of the term of reference	Do not add value	The ideal is that this verification does not have to be performed and for this it is necessary that the actors are trained to convey clearly and understand the necessary information without the need for rework.	RT

Label of organization's sectors	Engineering department - A Planning Coordination - B Engineering Coordination - C	Engineering Division – D Setor E of the public institution - E
Product label	Electrical infrastructure Feasibility study - EIFS Environmental feasibility study - EFS Urban feasibility study - UFS Preliminary study - PS Needs program - NP	Architectural design – AD Descriptive memorial – DM Justification memorial – JM Reference term - RT