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ORIGINAL ARTICLE

Proposal process management at the plant operation applied to the generating unit shutdown process of Itaipu Binacional

Proposta de gestão de processos na operação de usina aplicada ao processo de desligamento de unidade geradora da Itaipu Binacional

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Abstract: The Process Management is a model that enables the functional management of internal processes, cross or not an organization. Enables adequate control of resources, mapping of functions and activities, and aims to improve the results and sustainability. In line with these objectives, the Plant Operation Area Itaipu Binacional interests to map, identify areas for improvement and adequately control its internal processes, one of the shutdown, scheduled and unscheduled, generating units. This work is subject to application of Pereira Júnior method Process Management to shutdown generating units. Justified by the fact that Itaipu aims by 2020 to consolidate as the "[...] generating clean, renewable energy with the best operating performance and the best sustainability practices in the world [...]" (Itaipu Binacional, 2016). For this, has as some of the Strategic Objectives "To improve the efficiency of energy production processes maintaining the technological infrastructure updated" and "[...] foster an organizational culture focused on process efficiency and results" (Itaipu Binacional, 2016). To this end, the various hierarchical levels people were interviewed to map the scheduled shutdown process and unplanned generating units of Itaipu Binacional and raised the requirements for generation of performance and improvement opportunities indicators. Finally, alternative solutions have been suggested to improve opportunities raised, as well as an action plan linked to them.

Keywords: Process management; Processes improvement; Quality management.

Resumo: A Gestão de Processos é um modelo que possibilita a gestão funcional dos processos internos, transversais ou não, de uma organização. Possibilita o controle adequado dos recursos, mapeamento das funções e atividades, e tem por fim a melhoria dos resultados com sustentabilidade. Alinhada a tais objetivos, à Área de Operação da Usina Itaipu Binacional interessa mapear, identificar pontos de melhoria e controlar de forma adequada seus processos

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internos, um deles o desligamento, programado e não programado, de unidades geradoras. Este trabalho tem por tema a aplicação do método Pereira Júnior de Gestão de Processos ao desligamento de unidades geradoras. Justifica-se pelo fato de que a Itaipu Binacional pretende, até 2020, se consolidar como a "[...] geradora de energia limpa e renovável com o melhor desempenho operativo e as melhores práticas de sustentabilidade do mundo [...]" (Itaipu Binacional, 2016). Para isso, possui como alguns dos Objetivos Estratégicos "Aperfeiçoar a eficiência dos processos de produção de energia mantendo atualizada a infraestrutura tecnológica [...]" e "Fomentar uma cultura organizacional com foco na eficiência dos processos e nos resultados" (Itaipu Binacional, 2016). Para tal fim, foram entrevistadas pessoas de variados níveis hierárquicos para mapear o processo de desligamento programado e não programado de unidades geradoras da Itaipu Binacional, e levantados os requisitos para geração de indicadores de desempenho e oportunidades de melhoria. Por fim, foram sugeridas alternativas de solução para as oportunidades de melhoria levantadas, bem como um plano de ação vinculado a elas.

Palavras-chave: Gestão de processos; Melhoria de processos; Gestão da qualidade.

1 Introduction

"Industry" usually denotes a set of activities that seek the transformation of raw materials into consumer goods. In the case of the electricity industry, there is an intangible good generated – electricity, used for the production of light, heat, movement or any other energy transformation (ABRADEE, 2016). The hydroelectric segment is responsible for 61.37% of the electricity generated in Brazil, with 1,225 plants with installed capacity of 95,623MW, of which Itaipu Binacional HPP represent 14,000MW (ANEEL, 2016). A significant factor to be mentioned about the production and consumption of electricity is that, unlike other grid systems such as sanitation and gas, electricity cannot be stored in an economically viable way, resulting in the obligation to continuously balance supply and demand. That is, all the generated energy must be consumed immediately, and when the system is unbalanced, it runs the risk of collapsing or deficit (ABRADEE, 2016).

For the accomplishment of this work, the application of the Pereira Júnior Method for the process of planned and unplanned shutdown of the generating unit of the Itaipu Binacional HPP will be proposed. It is justified by the fact that Itaipu Binacional's strategic planning intends that by 2020 the plant will be consolidated as the "[…] clean, renewable energy with the best operational performance and sustainability practices in the world […]" (Itaipu Binacional, 2016). For the purpose of this paper, people of different hierarchical levels were interviewed to map the process of planned and unplanned shutdown of Itaipu Binacional's generating units, and requirements for generating performance indicators and opportunities for improvement were raised. Finally, alternative solutions to the opportunities for improvement were suggested, as well as a plan of action linked to them.

2 Objectives

2.1 General

To study the benefits of the Pereira Júnior Management Method (Pereira, 2010) to the process of planned and unplanned shutdown of a generating unit of the Itaipu Binacional Hydro Power Plant.

2.2 Specifics

a) To map the shutdown process of the generating unit;

b) To identify opportunities for improvement of the process;

c) To suggest the application of the process management method.

3 Theoretical reference

3.1 Processes

According to Davenport (1994), 'process' is a set of organized activities and expected models of products or services for customers, such as the flow of materials used in the transformation of inputs into outputs. Krajewski (2014) points out that the process view provides a more relevant picture of the way companies work. Since a process can contain its own set of objectives, it involves a workflow that crosses departmental boundaries, so the secret of the success of many organizations is to have a broad understanding of how their processes work and how the whole organization should be involved in their analysis.

3.2 Process management

Companies develop several operations that bring results. These operations can be called processes, which, in an integrated way, strive to guarantee the goals of the organizations (Davenport, 1994).

The process management, according to Oliveira (2007), is the reorganization of the impacts between strategic and organizational processes to optimize value added and business effects. Davenport (1994) states that process management, besides helping to reduce costs, also decreases process delays and improves quality, service levels and flexibility.

Coulson-Thomas (1996) explains that processes vary according to the demands of production, efficiency and flexibility. Usually, the owner of the process has to have strongly defined responsibilities. Each step should be constantly evaluated and restructured in order to make it more efficient.

In the 1990s, process management was the most discussed and intensified proposal highlighted by the business world. Whilst some organizations adhered to management methods, others rejected before even knowing what it was. According to De Sordi (2008), the term process management appeared in the middle of the eighteenth century, at the beginning of the Industrial Revolution, by dividing the work into sequential activities with the aim of mechanization. It is currently used by professionals in the industrial operations area

According to De Sordi (2008), process management is an administrative approach that has a style of organization and management of business operations. "Although very present, the concept of process does not have a single interpretation, and the variety of meanings found has generated numerous misunderstandings" (Gonçalves, 2000, p. 6).

4 Methodology

4.1 General vision of the adopted method

The Pereira Júnior Method (Pereira, 2010) is composed by three phases and eight stages, according to the Figure 1.

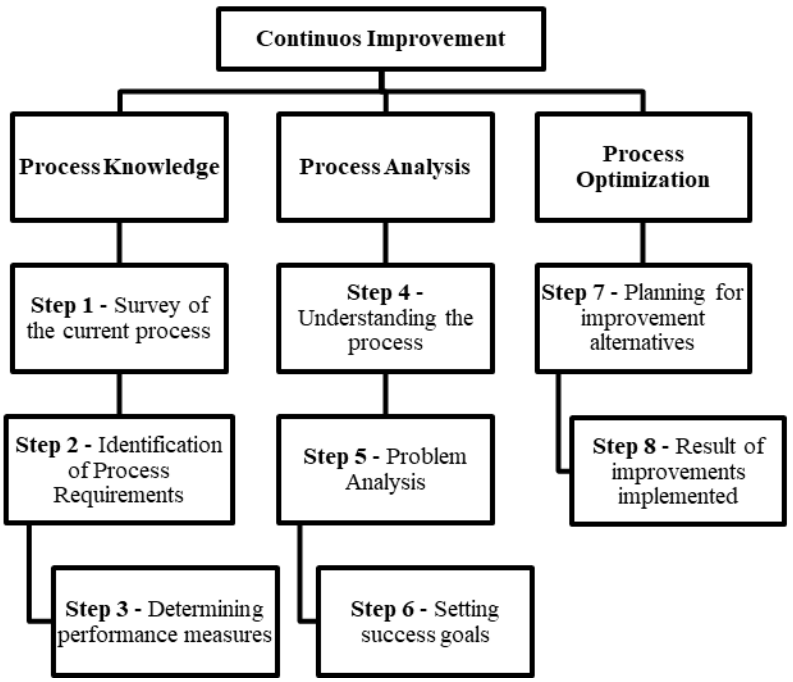

Figure 1. Process Management Method. Source: Adapted Pereira (2010).

4.1.1 Phase 1: Process knowlegement

At this phase, the structure of the processes is delimited, in addition to the construction of the process diagram, which is composed of all macrodiagrams of the organization. This phase consists of three stages, described below.

4.1.2 Stage 1 – Survey of the current process

Determines the scope of the current process, specifies its mission, the beginning, the end, the encompassing and the facilitator who is aware of the process to be studied. Another focus of this stage to be determined is the macrodiagram of the process, which specifies: process inputs; suppliers; outputs; customers; and the subprocesses. Then, with the identification of each subprocess, the mapping is started by using the flowchart technique, evidencing the activities of the process, their interrelationships, the order in which they are executed and who carries out each one of the activities.

4.1.3 Stage 2 – Identification of the process requirements

Determines the requirements, needs and expectations of the organization and the client, understanding how the process is acting to serve them. According to the data identified in the previous stage, interviews are conducted with clients to understand their expectations and needs, and thus identify the requirements that generate value for them. This activity is critical because if it is not executed efficiently, it will translate erroneously the customer's wishes. Thus, motivate improvements in topics that will not make the process effective. Next, all requirements pointed out by the clients are correlated, defining the regularity with which they were mentioned. The requirements that had the highest occurrence should be considered critical and important. Finally, check the performance of these critical requirements. In process management, the processes chosen to be worked on are usually the ones focused on the organization's main strategies, that is, they will have greater support in the realization.

4.1.4 Stage 3 – Determination of performance measures

The determination of the performance measures aims to determine performance indicators to measure each requirement that add value to the customer. Several indicators are generated, establishing a set of measures. These indicators need to be validated by the study team and by the process facilitator in order to obtain indicators that effectively evaluate the value aggregation. In addition, they need to be obtained in a simple way, with clarity, ease of deployment and periodically measured.

4.1.5 Phase 2 – Process analysis

At this stage the process is thoroughly analysed, its performance and the topics that may be causing failures to the customer evaluated. Then, the possible problems that generate these failures are determined, their possible root causes investigated. Therefore, improvement actions are established in order to extinguish the causes. Based on this knowledge, the critical success factors will be identified and the goals established so that the outputs of the process generate value to the client.

4.1.6 Stage 4 – Process understanding

In order to better understand the current process, the Macrodiagram and Process Map developed in Stage 1 are used, allowing an in-depth verification of all activities, their relationshiops, process members, inputs and outputs. The second activity to be performed will be the inquiry of each activity, especially those that directly influence the clients' requirements. The requirements with the lowest performance by the clients will be examined in order to analyse the constraints and ruptures that influence the overall performance. This stage plays an important role in developing plans for future improvements, resulting in the following results: identification of the level of performance achieved; chronic issues; opportunities for improvement; the main dependencies; integrity of systems; existing improvement plans; and barriers to improvement.

4.1.7 Stage 5 – Problem analysis

Based on the identification of the process problems, this stage has the purpose of determining the possible root causes. These can be obtained with the use of some method of analysis and problem solving, associated with problem identification tools, such as the Ishikawa Diagram. It is vital at this stage to determine the potential problems. A database is generated for recommending improvements and setting process success goals, which will be the next steps of this method.

4.1.8 Stage 6 – Definition of the success goals

The goals are established by the determination of the critical success factors. They require performance levels that meet or exceed customer expectations. However, it will be critical considering the organization's strategies to achieve competitive information in the marketplace.

4.1.9 Phase 3: Process optimization

At this stage the alternatives of improvement for the process will be defined, in order to meet the needs and exceed the expectations. Solutions to the problems encountered in the analysis phase are identified in order to eliminate their root causes. Then, a plan of action will be set up to achieve the proposed improvements, aiming at a future situation. Shortly thereafter, a pilot plan for improvements is implemented.

4.1.10 Stage 7 – Planning of improvement alternatives

Following the definition of the goals of success are the alternatives of improvement. It is necessary to prioritize the recommended improvement opportunities, the urgency of the actions and the level of performance required. Therefore, a plan for implementation will be established in order to validate success goals, perform changes in activities, improve the information systems and carry out partial or total redesign of the process. Subsequently, the future situation of the process is planned and the new model is elaborated. Improvement actions, success goals, and the new process model need to be valued by everyone involved as well as those with decision-making power.

4.1.11 Stage 8 – Results

Check the established goals and make the necessary changes frequently, as well as assisting in the implementation and certification of the improvements. The advantages obtained through the method should be proven, such as cycle times, costs and customer satisfaction, among others. All documents obtained when the work is being carried out should be stored, the facilitator should follow the application of the method and the organization managers should be kept informed with follow-up reports.

5 Results and discussion

5.1 Description of the planned and unplanned shutting down of the generator unit

The shutdowns of the Itaipu Binacional generating units may occur in three situations: periodic maintenance (planned shutdowns), aperiodic maintenance (unplanned shutdowns) and automatic shutdown.

The periodic maintenance plan is conducted mainly for prevention, necessary to assure the integrity of the equipment and also to obey administratively stipulated criteria. Each main equipment of the power plant has its periodic maintenance planning, based on the history of previous years and imposed operational needs.

Aperiodic maintenances rise from anomalies: failure to perform maintenance can compromise the production of energy or even the safety of people, of the installation or of the environment surroundings. Or it can be originated from real-time alarms, following operational instructions that demand the unit shutdown based on the alarm attendance criteria.

Operational inspections can also result in unplanned shutdowns; in the event that the operator finds some defect during its inspection process, the Shift Supervisor is warned, and he will determine the degree of attendance of the occurrence according to the current operating instructions. Both the alarm and alarm shutdown process inspection will be treated in the same way. When decision makers, based on the concepts available in the current operating instructions or their experience or other professionals' experience, reach the conclusion that the degree of care for the occurrence is urgent, they decide immediately contact the maintenance and the load dispatch. The shutdown is coordinated and the required documentation is issued. When necessary, isolation of the equipment is performed by the operation team, and then released for maintenance. In case the operation supervisor concludes that it is an emergency, the shutdown is done immediately with no need to contact anyone, and then the necessary documentation is issued. It is considered an emergency when in the event causes imminent risk to the physical integrity of the people, the environment surrounding and the facilities.

Automatic shutdown may occur by the equipment protection. Protection devices monitor conditions and protect system components against possible faults to avoid damage, reducing the time and especially costs of repairing. Stops caused by automatic shutdown of the generating unit will not be dealt with in this study, as it does not involve decision making.

5.2 Phase 1 – process knowledgement

5.2.1 Stage 1 – Actual Process Survey

The first step to be conducted to survey the current state is the delimitation of responsibilities, defining the leader, the team of improvement and the responsibilities of each participant, as shown in Chart 1.

Chart 1. Responsibilities.

PARTICIPANT	RESPONSIBILITY
LEADER	Industrial engineering professional. Proposal for the development of this methodology and follow-up of the study of the process.
IMPROVEMENT TEAM	Industrial engineering professionals and facilitator. Responsible for for data collection, mapping and study of the process.
FACILITATOR	Supervisor of the Operation area. Responsible for giving necessary feedbacks to the study carried out by the trainees, and provide technical and decision support.

Source: Own authorship, 2016.

Once the responsibilities are defined, the work plan containing the activity schedule is established and dates are set for compliance with the eight steps, as shown in Chart 2.

Chart 2. Work Plan.

STAGES	DESCRIPTION	RESOURCES	DEADLINE	RESPONSIBLE
STAGE 1	Make a visit to the sector, question the responsible and collect data.	Computer	05/02/16	Improvement team
STAGE 2	Analyse process requirements	Computer	06/01/16	Improvement team
STAGE 3	Define patterns.	Quality tools	06/08/16	Improvement team
STAGE 4	Understand the operation of the process through a flowchart and process map.	Flowchart/Visio®	06/09/16	Improvement team
STAGE 5	Talk to the responsible to identify gaps.	Interview	07/01/16	Improvement team
STAGE 6	Set goals for success.	Didactic resources	07/10/16	Leader/Facilitator
STAGE 7	Create a plan of action.	Computer	07/20/16	Leader/Facilitator
STAGE 8	Compare the results.	Computer	07/30/16	Leader/Facilitator

Source: Own authorship, 2016.

The scope is the detailed description of the process or product; it is possible to define boundaries of the project, the beginning, the end and the objective, identifying what happens in the process. The data obtained for the establishment of the scope was carried out through interviews with those involved in the process, as shown in Chart 3.

Chart 3. Scope process.

SCOPE
Name: Generating Unit Shutdown
Objective: Safely disconnect the generating unit from the electrical systems to perform preventive or corrective maintenance.
Begins with: The maintenance plan or an anomaly detection.
Ends with: Return of the unit to the system.

Source: Own authorship, 2016.

To map the entire process is necessary the identification of the components and the knowledge of all elements involved and how each one influences the others. The macrodiagram is illustrated in Figure 2.

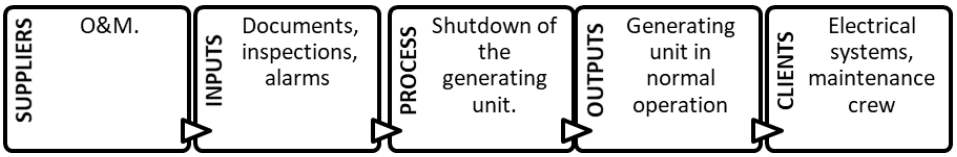

Figure 2. Macrodiagram. Source: Own authorship, 2016.

The next task was the construction of the process maps for the planned and unplanned process of the shutdown of the generating unit, as shown in Figures 3 and 4 (CNMP, 2013).

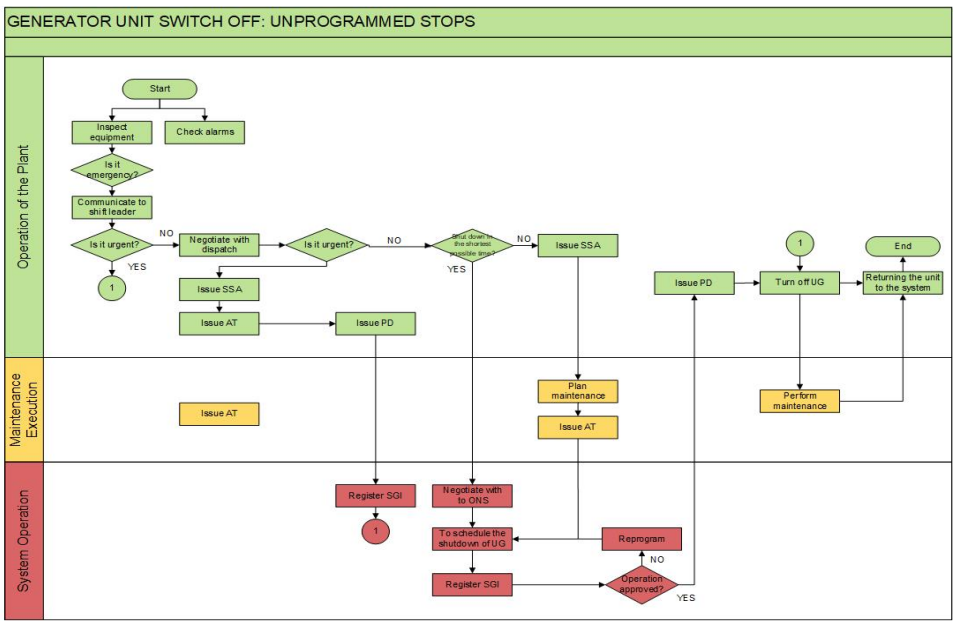

Figure 3. Actual process map for the unplanned shutdown of the generating unit.
Source: Own authorship, 2016.

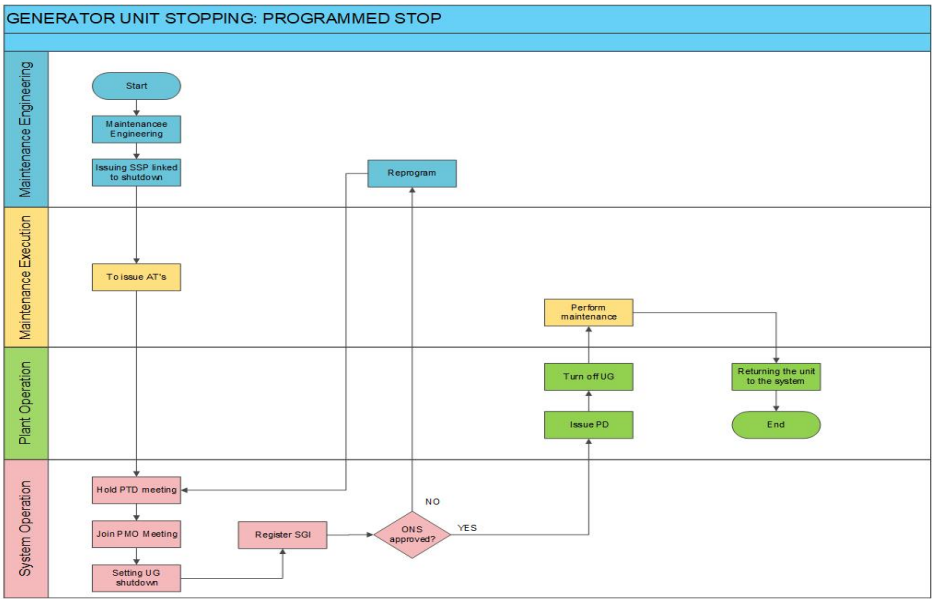

Figure 4. Actual process map for the planned shutdown of the generating unit.
Source: Own authorship, 2016.

5.2.2 Stage 2: Analyse process requirements

According to Pereira (2010), the requirements are sets of expectations that a product or service needs to attend. Therefore it was necessary to talk to the customer and process participants to identify the desired requirements, described below in Chart 4.

Through interviews with those involved, the following requirements for the shutdown of the generating unit were established.

Chart 4. Description of process requirements.

REQUIREMENTS	DESCRIPTION
SAFETY	Ensure safe practices for people, environment and installation
WELL-DEFINED PROCEDURES	Techniques, process and methods of work well established
ADEQUATE TRAINING	Acquisition of knowledge, skills and competencies that fit the need of the process
FAILURE RATE	The loss of an item's ability to perform its function
HUMAN RESOURCES	When there is a need for relocation of people or admission of new employees
AVAILABILITY	Is the time the equipment is available to operate or installation and system to produce
RELIABILITY	It is the probability that an item can perform its required function per unit of time

Source: Own authorship, 2016.

These requirements will serve as a basis for the study of the “Importance-Performance Matrix”. After identifying the requirements of the clients, the ones with the highest priority were studied. Chart 5 below reflects the results obtained through customer research, where they could assign scores from 0 (zero) to 5 (five) for the importance and performance of the disconnection of the generating unit.

Chart 5. Average Importance x Performance.

	REQUIREMENTS/ SCORE	IMPORTANCE	PERFORMANCE	PRIORITY
1	Availability	4.00	4.00	4
2	Reliability	4.50	4.50	5
3	Safety	4.50	4.50	6
4	Well-defined procedures	3.00	3.00	1
5	Training	3.00	3.00	2
6	Failure rate	4.00	4.50	7
7	Human resources	3.00	3.00	3
	Average	3.71	3.78	

Source: Own authorship, 2016.

The results observed correspondance to the number of people who assigned the importance and performance of the items involved. In total, interviews were conducted to 90% of those involved. After identifying the customer requirements, the priority was defined, and then the “Importance-Performance Matrix” was assembled, as shown in Figure 5.

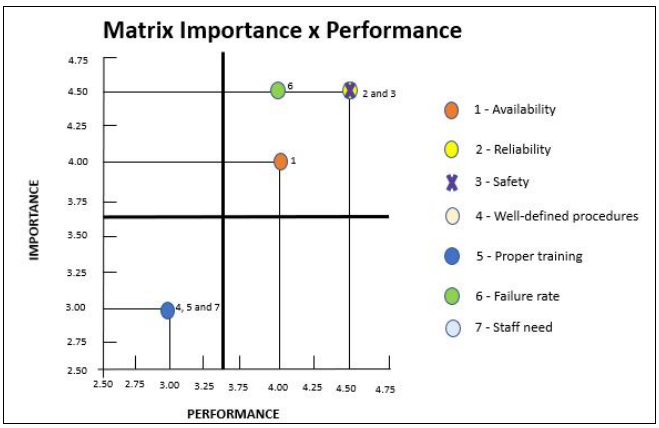

Figure 5. Matrix Importance x Performance. Source: Own authorship, 2016.

From the “Importance-Performance Matrix”, it was verified that the priority and most urgent requirements to be met are those that were below the central prioritization quadrant, which are: 4 (well-defined procedures), 5 (training) and 7 (human resources).

5.2.3 Stage 3 – Determination of the Performance Measures

In stage three, the prioritized requirements are used to fill the table and create performance indicators, as shown in Chart 6. The performance indicators monitor the processes, so it is fundamental to determine, in order to use the measured data, increase the character of professionalism, which also influences the culture of merit by results (CNMP, 2013).

Chart 6. Performance indicators.

REQUIREMENTS	WELL-DEFINED PROCEDURES	TRAINING	HUMAN RESOURCES
INDICATOR	Efficiency	Investiment return rate	Productivity indicators
WHY TO MEASURE?	To certify in which measure the operational procedures are being followed	To attest the knowledge level of employees	Check if more people are needed to do these jobs
WHAT TO MEASURE?	If the procedures are defined, through the efficiency index	The level of knowledge of employees, through the return on investment index	What is the need for personnel, through the productivity index
HOW TO MEASURE?	$\frac{\text{Expected Resources}}{\text{Resources Used}}$	$\frac{(\text{Benefits} - \text{Costs})*100}{\text{Overall costs of the training program}}$	$\frac{\text{Used or Available Resources}}{\text{Total produced}}$
WHEN TO MEASURE?	By the end of the semester	By the end of the semester	By the end of the semester
WHICH PERIODICITY	Semester	Semester	Semester
WHO MEASURES?	Improvement team	Improvement team	Improvement team
STAKEHOLDERS	Improvement team	Improvement team	Improvement team

Source: Own authorship, 2016.

5.3 Phase 2 – Process analysis

5.3.1 Stage 4 – Understanding of the process

In order to obtain a better understanding of the process, it was necessary to interview those involved for the creation of frameworks in order to diagnose the opportunities for improvement. As shown in Chart 7 and Chart 8, which present the diagnosis drawn from interviews with process clients:

Chart 7. Unscheduled Shutdown Process Diagnostics.

	Description	Objective	Como ocorre	Problem	Opportunity for improvement
1	Inspecting equipment	The equipment is inspected by the operator	Checks whether the equipment operates correctly.	NA	NA
2	Inspection OK?	Check for any problems	Finding some failure or defect	NA	NA
3	Verify alarms	Check the cause of the alarm being triggered	Identifying where the alarm came from	NA	NA
4	Communication with the operation chief	The identified problem is reported to the shift leader for possible actions	The operator reports the abnormality in person	NA	NA
5	Emergency?	Identify if the situation fits into an emergency situation	Identify who states the severity of the event	Improve the definition of decision parameters	Creation of new definitions and training for employees

	Description	Objective	Como ocorre	Problem	Opportunity for improvement
6	Negociate with dispatch load center	The stop of the GU is negotiated in real time	Check if electrical conditions permit the shutdown of the GU at the moment	NA	NA
7	Urgent?	Identify if the situation fits into an urgency	Identify who decides about the severity of the event	Improve the definition of decision parameters	Creation of new definitions and training for employees
8	Issuance of the documentation for the shutdown (service solicitacion)	Issue a document describing the problem to the maintenance crew	The operator fills in the form where the type of problem is reported and where it is located	NA	NA
9	Issuance of the documentation for the shutdown (work permits)	The maintenance crew issues a work permit, analysed by the operation crew, so that the responsible team can perform the intervention.	Maintenance issues the work permit	NA	NA
10	Register maintenance in the electrical system	The dispatch is responsible for conducting the negotiations with the ONS, in the event that a stop should be formalized, through the document IMS (Intervention Management System)	Dispatch formalizes the shutdown request	NA	NA
11	Disconnect in the shortest possible time?	Identify if it is necessary to shutdown the GU in the shortest possible time	Identify who decides about the severity of the event	Improve the definition of decision parameters	Creation of new definitions and training for employees
12	Negociate with the electrical system	Negotiations with the electrical systems about the feasible time to perform the maintenance	The operation of the system negotiates with ONS the best date and time for the unit to be stopped.	NA	NA
13	Program shutdown of the GU	Scheduled to be carried out in the shortest possible time, checking the most appropriate time.	Checking the best date with the severity of the problem	NA	NA
14	Register maintenance in the electrical system	The dispatch is responsible for conducting the negotiations with the ONS, in the event that a stop should be formalized, through the document IMS (Intervention Management System)	Dispatch formalizes the shutdown request	NA	NA

	Description	Objective	Como ocorre	Problem	Opportunity for improvement
15	The electrical system approved?	The ONS approves or disapproves the request for disconnection via e-mail, if approved the Shutdown Request issued and if refused, the shutdown is rescheduled.	ONS sends e-mail to the operation crew, approving or disapproving the intervention	The planning is lost when the ONS doesn't approve	Create new parameters for these cases
16	Reschedule	A new schedule is made to the shutdown	Verifying the best date and time for the intervention	Delivery of the request in a short time	Review the deadlines for submitting the requests
17	Issuance of the documentation for the shutdown (service solicitacion)	Issue a document describing the problem to the maintenance crew	The operator fills in the form where the type of problem is reported and where it is located	NA	NA
18	Plan the maintenance	According to the anual maintenance plan of GUs.	Annual plan approved	NA	NA
19	Issuance of the documentation for the shutdown (work permits)	The maintenance crew issues a work permit, analysed by the operation crew, so that the responsible team can perform the intervention.	Maintenance issues the work permit	NA	NA
20	Issuance of the documentation for the shutdown (shutdown request)	With the approval of ONS to perform the shutdown of the UG, the operation of the plant issues the request for shutdown.	The operation issues the request for shutdown	NA	NA
21	Shutdown of the GU	The real-time operation team shutdowns the GU and isolates to the maintenance crew.	Shutdown and isolate the GU	NA	NA
22	Perform the maintenance	The maintenance team performs the necessary repairs on the GU.	Do the necessary repairs	NA	Create an environment to include all pendencies in the stop
23	Return the GU to normal operation	The operation team returns the GU to the electrical system.	By operational maneuvers	NA	NA

Source: Own authorship, 2016.

Chart 8. Scheduled Shutdown Process Diagnostics.

	Description	Objective	Como ocorre	Problem	Opportunity for improvement
1	Plan the maintenance	According to the anual maintenance plan of GUs.	Annual plan approved	NA	Greater agility to the plan to reach the maintenance execution
2	Issue documentation regarding the shutdown	The maintenance crew issues a periodic service request		NA	Training with the systems rules
3	Issuance of the documentation for the shutdown (work permits)	The maintenance crew issues a work permit, analysed by the operation crew, so that the responsible team can perform the intervention.	Maintenance issues the work permit	Deadlines	Meetings seeking for agreements regarding the dates
4	Realize the interdepartamental meeting	Meeting with O&M where the shutdown requests are analysed	With the participation of at least one member of each responsible division. It is realized each month	NA	NA
5	Scheduling of the shutdown of the GU	The shutdown is scheduled for the shortest possible time	How bad is the problem?, it is the question to be answered	NA	NA
6	Register maintenance in the electrical system	The dispatch is responsible for conducting the negotiations with the ONS, in the event that a stop should be formalized, through the document IMS (Intervention Management System)	Dispatch formalizes the shutdown request	NA	NA
7	Register maintenance in the electrical system	The dispatch is responsible for conducting the negotiations with the ONS, in the event that a stop should be formalized, through the document IMS (Intervention Management System)	Dispatch formalizes the shutdown request	NA	NA
8	The operation crew approved?	The operation of the plant, along with the ONS, approves or disapproves the request	By e-mail	Need for rescheduling	Create new parameters for these cases

	Description	Objective	Como ocorre	Problem	Opportunity for improvement
9	Issuance of the documentation for the shutdown (shutdown request)	With the approval of ONS to perform the shutdown of the UG, the operation of the plant issues the request for shutdown.	The operation issues the request for shutdown	NA	NA
10	Shutdown of the GU	The real-time operation team shutdowns the GU and isolates to the maintenance crew.	Shutdown and isolate the GU	NA	NA
11	Return the GU to normal operation	The operation team returns the GU to the electrical system.	By operational maneuvers	NA	NA
12	Reschedule	A new schedule is made to the shutdown	Verifying the best date and time for the intervention	Simultaneous shutdowns	Review the deadlines for submitting the requests

Source: Own authorship, 2016.

5.3.2 Stage 5 – Problem analysis

After the process was diagnosed, the improvement team identified the probable causes of nonconformation of the processes, based on the problems (effects) identified in Stage 4 – Understanding the Process. Potential solutions were proposed for the causes mentioned.

Effect 1: Need for rescheduling, shown in Figure 6.

Potential causes:

- External factors such as other plants with higher priority of shutdown;
- Non-approval of the operation crew due to systemic needs;
- Priority to UG (generating unit) that has a more serious problem.

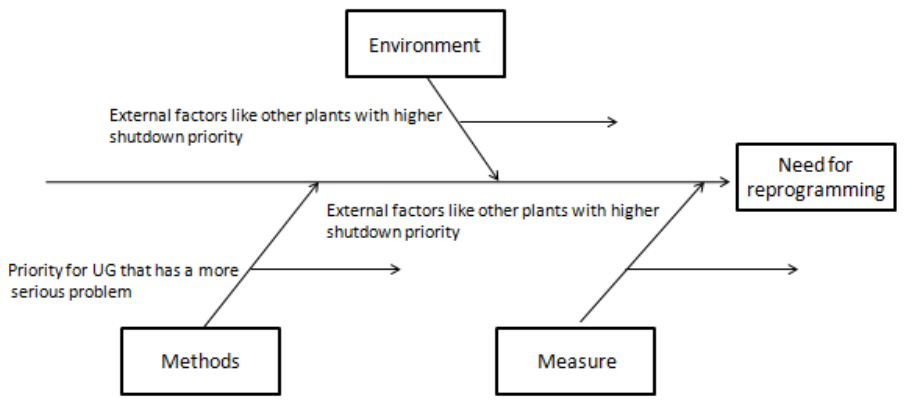

Figure 6. Ishikawa Diagram for the Effect 1. Source: Own authorship, 2016.

Effect 2: Need to switch off the UG simultaneously with another that is already switched off, shown in Figure 7.

Potential causes:

- Severity of the problem;
- Management decision (ex: maximum term of dismissal);
- Automatic protection shutdown.

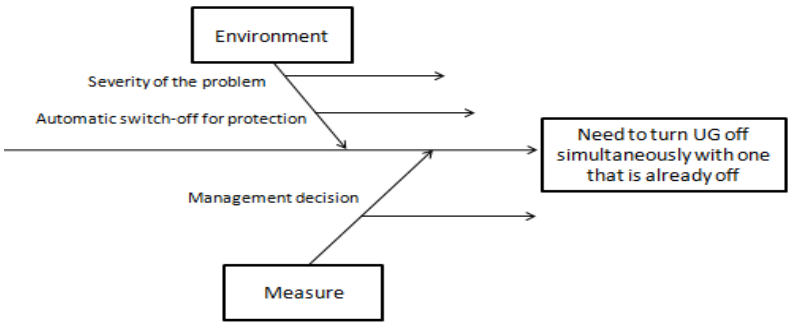

Figure 7. Ishikawa Diagram for the Effect 2. Source: Own authorship, 2016.

Effect 3: Divergences in the decision of the degree of care, illustrated in Figure 8.
Potential causes:

- Lack of standardized definition;
- Lack of training to introduce the concept;
- In some cases, there is a need for opinion from other areas for decision making.

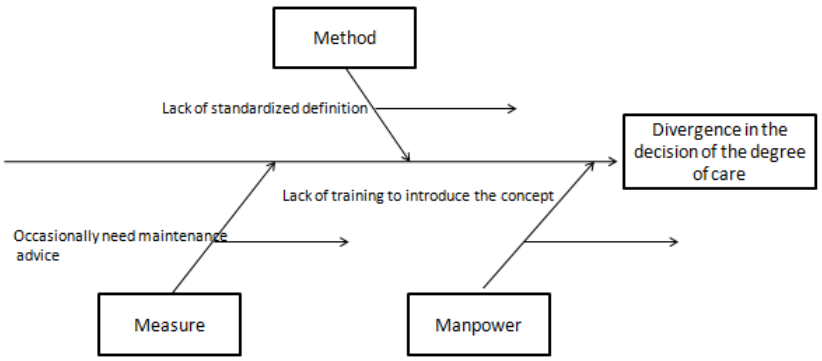

Figure 8. Ishikawa Diagram for the Effect 3. Source: Own authorship, 2016.

From the causes and effects were raised solutions that were used to define the next phase of creating goals, as described in Chart 9.

Chart 9. Potential solutions.

EFFECT	CAUSE	POTENTIAL SOLUTIONS
Divergences in the decision on the degree of care	- Lack of standardized definition; Lack of training to introduce the concept; in some cases, there is a need for opinion from other areas for decision making.	- Creation of a pattern;
Divergences in the decision of the degree of attendance / Need of rescheduling	- Lack of standardized definition; Lack of training to introduce the concept; in some cases, there is a need for opinion from other areas for decision making. - External factors such as other plants with higher priority of shutdown; Non-approval of the operation crew due to systemic needs; Priority to UG (generating unit) that has a more serious problem	- Seek for stronger integration with the areas involved;
Need of rescheduling	- External factors such as other plants with higher priority of shutdown; Non-approval of the operation crew due to systemic needs; Priority to UG (generating unit) that has a more serious problem.	- Review the deadlines;
Divergences in the decision of the degree of attendance / Need of rescheduling	- Lack of standardized definition; Lack of training to introduce the concept; in some cases, there is a need for opinion from other areas for decision making. - External factors such as other plants with higher priority of shutdown; Non-approval of the operation crew due to systemic needs; Priority to UG (generating unit) that has a more serious problem	- Training for all those involved in the process.

Source: Own authorship, 2016.

5.4 Phase 3 – Process optimization

5.4.1 Stage 6 – Definition of goals

Firstly, the study was carried out in order to identify critical success factors, which aim to meet the priority requirements identified in the “Importance-Performance Matrix”. Clients of the process were consulted about the current performance. It was necessary to know the expectations, needs, quality requirements and the degree of customer satisfaction with the evaluated processes. Some critical success factors (CSF) were identified:

- Standardization of the degree of care of the problem found in the GU;
- Knowledge of the process;
- Quality of service.

From the critical success factors, the goals described in Chart 10 were prepared for the planned shutdown of the generating unit and for the unplanned shutdown

Chart 10. Goals.

(CSF)	GOALS	ACTION	DEADLINE
Standardization of the degree of care of the problem found in the GU	Improve the definition and understanding of the degree of care by the O&M crews by 50%.	Interviews with involved areas	6 months
Knowledge of the process	Standarize 100% of the common information.	A study developed together with the sectors involved	1 year
Quality of service	Improve quality of service by 5%	From the application of the manuals and follow-up	1 year

Source: Own authorship, 2016.

5.4.2 Stage 7 – Planning the planejamento de improvement alternatives

According to Pereira Júnior (Pereira, 2010), after the definition of the success goals the alternatives of improvement of the process were planned, based on the analysis performed in stage 5.

The improvement opportunities were prioritized, based on the influence they carry out in the process outputs, according to the best level of customer service. An improvement action plan was set up to validate the goals created in stage 6, as described in Chart 11.

Chart 11. Improvement Action Plan.

ACTION	RESPONSIBLE	DEADLINE
Creation of new manuals, containing all the necessary information for the accomplishment of the shutdown, realization of the maintenance and return of the operation to the system for planned and unplanned shutdown	At least one representative of each sector	In 1 year
Training for the employees involved in the process (sectors of system operation, pre-operation, real-time operation, post-operation, maintenance engineering and maintenance execution) so that the procedures are defined at the level of no failures or doubts	Representative of the operation	In 6 months
Integration between the areas, where the systemic approach of the process is presented, so that each member knows the importance of their service in the process and can contribute with an overview of the process	One representative of each sector, that will serve as a facilitator for the other componentes of his sector	In 1 year
Availability of human resources. Relocation of personnel or admission of new employees will be necessary to improve the distribution of tasks and not to overwhelm members.	HR and one representative from each sector involved.	In 1 year

Source: Own authorship, 2016.

As a consequence of the improvement action plan, a change in activities or flow can be made to improve and redesign the improved process as illustrated in Figure 9 and Figure 10.

For the unplanned shutdowns, the main changes were in the improvement of the attendance level due to the creation of the new manuals, thus simplifying the flow and eliminating divergences in the decision-making process. In the case of planned shutdowns, the shutdown scheduling activity has been eliminated, due to the fact that scheduling is already performed at the PTD (Quarterly Shutdown Planning) Meeting.

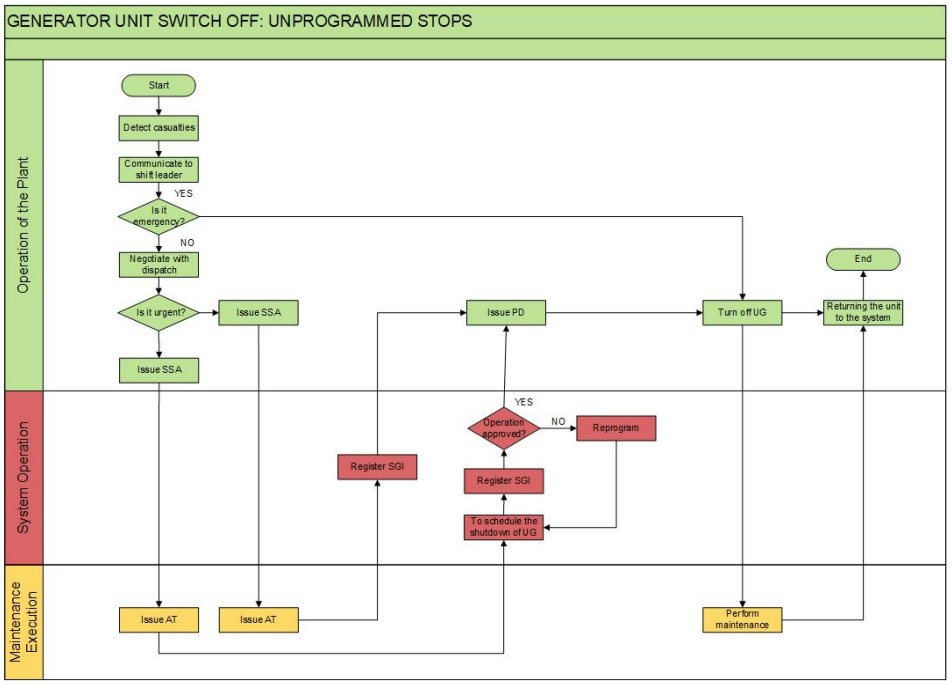

Figure 9. Improved process map for the unplanned shutdown. Source: Own authorship, 2016.

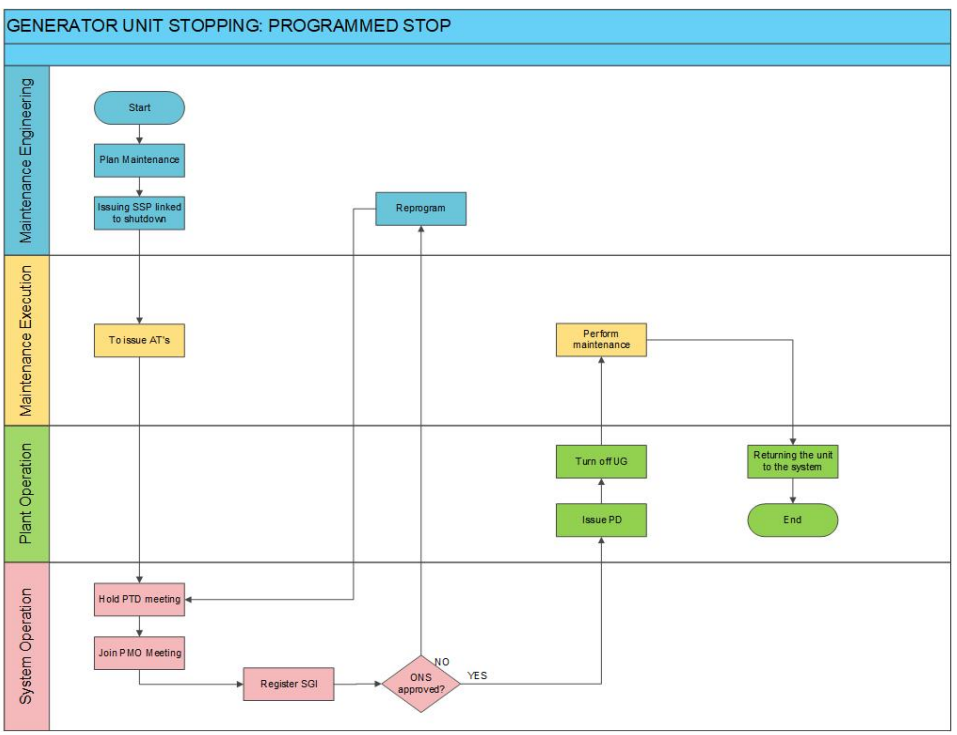

Figure 10. Improved process map for the planned shutdown. Source: Own authorship, 2016.

The changes in the process maps were based on the suggested improvements, where it is noted a significant change in the map of the unplanned shutdown process.

5.4.3 Stage 8 – Results of the improvements

The decision of the implementation of the process management depends on the decision of the top management of the company, which will be for an upcoming work. All generated documents were forwarded to the responsibles.

6 Final considerations

This work had the theme of Process Management through the application of the Pereira Júnior method in the process of planned and unplanned shutdown of the generating unit of the Itaipu Binacional Hydro Power Plant, a transversal process that involves several areas within the Technical Directorate of the company.

Interviews were conducted with the functional staff and managers of all sectors involved in the process, with the intention of map all process. These actors identified the process requirements, adding scores to the importance of each requirement for the overall performance. To the requirements considered to be priorities in terms of performance, indicators had been assigned, helping managers to control and, if necessary, produce improvement actions. With the requisites and indicators in hand, new interviews were conducted with the purpose of diagnosing the process and raising the main problems and causes of nonconformities. Finally, a specific planning was made for the proposed improvement alternatives. From the conclusions of the improvement action plan, new maps of the planned and unplanned shutdown processes were proposed.

It was concluded that, due to the opportunity of improvement of a standardized process mapping, there are some subtle differences - which do not significantly impact the overall result - of process understanding both among hierarchical levels and among the sectors involved. Process Management can contribute to standardize these understandings and the internal activities of the process.

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