

CENTERIS 2012 - Conference on ENTERprise Information Systems / HCIST 2012 - International  
Conference on Health and Social Care Information Systems and Technologies

## EX-ANTE and EX-POST Model applied to the Operational Flying Regime Management

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### Abstract

The current international situation has caused serious budgetary constraints at the level of government organizations. To cope with the adversities the Portuguese Air Force (PoAF) has adopted new management mechanisms that aim to provide an effective and efficient management of scarce resources that the organization has at its disposal. The Integrated Management Defense System (IMDS) is the tool that the organization has adopted to solve the current restrictions. This tool is used at the operational level only for recording data relating to the operation performed, demonstrating a gap in relation to the management objectives, considering the totality of its processes. The theoretical support of the EX-ANTE and EX-POST Model, used in conjunction with the Zachman framework, allows the correlation of access control and registration and validation mechanisms within the correspondent information systems, which is essential to the organization that oversees governance through its architecture. Also, the introduction of planning data and the respective Key Performance Indicators (KPI) increase IMDS capabilities and align it with the management objectives outlined in the strategic level.

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*Keywords:* adaptability; business intelligence; management; enterprise governance; planning.

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## 1. Introduction

From the 80's comes the concept of Business Intelligence (BI) which assumes the ability of organizations to access data and exploit information, analyzing and developing insights and opinions about them that allow increased and better support decision making. The Portuguese Air Force (PoAF) has the responsibility: i) to prepare its operational planning in order to overcome vulnerabilities; ii) of raising levels of performance to fulfill the mission; iii) to contribute effectively and efficiently for safeguard of the national interest. Due to the difficult financial situation that the country is experiencing, reflected in budget cuts, it becomes imperative to rationalize and reduce the running costs of the organization, increasing operational efficiency.

To achieve the organization's management objectives it is essential that the PoAF adapts to the ever-changing environment in which it operates. This paper describes the research conducted to ascertain referential mechanism to improve the operational domain while increasing levels of effectiveness and efficiency. The research focused on studying and proposing changes to the Integrated Operational Management Information System (SIGOP), in order to solve some shortcomings in the monitoring and operational analysis on the Flying Regime (FR) helping the organization to overcome existing vulnerabilities and raise levels of performance on the Mission.

The research is based on knowledge theories and principles of Organizational Engineering (OE) that culminate in the adaptation of two models which allow the creation of a meta-model that applied to the IMDS provides the introduction of operational planning, as well as the necessary data to analyze KPI of all operational elements closely linked to crews, missions and aircraft.

## 2. Concepts and Application

This section presents the theoretical framework used to develop the research, divided into an overview of knowledge theories and principles used, and the scientific models directly involved in the development of the model proposed in Section 3.

### 2.1. Theories of Knowledge and Principles

The work is based on knowledge and principles of the Organizational Engineering (OE) to assist organizations in their constant quest for flexibility and adaptability enabling them to monitor the constantly changing environment in which they operate.

Therefore, an organization needs to fulfill the OE requirements that can be regarded as *“the body of knowledge, principles and practices related to analysis, design, implementation and operation of a company”* [1]. The concept of OE derives from Organizational Design and Engineering (ODE) that results from the *“application of knowledge generated by research and practice in the areas of social science and computers, for the study and implementation of new organizational models, including structuring, modeling, development and integrated implementation of artifacts and people”* [2].

The search for increased competitiveness through flexibility and adaptability of organizations led them to collect, retain and analyze data that enable them to access information that will help the organizations to make the right decisions in business. The result of these actions was the concept of Business Intelligence as a *“...more holistic and sophisticated approach to traverse the needs of decision support organizations. Uses data to gain hidden knowledge about customers, general market conditions, and competitive products. The goal is to “predict” the future, analyzing the present, thereby gaining a competitive advantage.”* [3].

Organizations use visual models that describe their current and future state to make communication easier and more effective *“a picture is worth more than a thousand words”*. These models are developed under the

Enterprise Architecture (EA) theory and concept. Zachman [4] states that *“Enterprise Architecture is a set of design artifacts, or descriptive representations that are relevant to describe an object that can be produced by quality requirements, as well as maintained over its useful life”*.

But in an environment occupied by people interacting in their various roles, conflicts can arise and it is necessary to use Enterprise Governance (EG) which is *“... the board’s legal authority to exercise power and authority over an organization on behalf of the community it serves. The board is authorized to establish policies and make decisions that will affect the life and work of the organization. The board is where the proverbial “buck” stops; it is also held accountable for the actions that follow those policies and decisions. Governance is group action. Individual board members do not govern the organization.”*[5]. This legal authority results, among other, in the ability to Business Rules structuring as an essential step to know the orientation of the whole business. The Business Rules Group (BRG) presents a model called the Business Motivation Model (BMM) that *“...provides a scheme or structure for developing, communicating, and managing business plans in an organized manner.”* [6] but *“what is needed to achieve what the enterprise wishes to achieve? This question is answered by laying out the particular elements of the business plans — in other words, the Means necessary to achieve the desired Ends.”* [6].

However, organizations need more than knowing what to do and how it should be done, they need also indicators to verify that they are doing what really needs to be done and whether they are achieving the results allowed with their actions, in other words *“You can’t manage anything unless you can measure.”* [7]. These metrics are called Key Performance Indicators (KPI) and *“... help the organization to spend its time on important activities that guide the performance and less time on activities that aren’t so relevant. Because the indicators are generally the most important metrics of an organization, are also often valuable content in the realization of a dashboard ”* [8]. Dashboards are an important piece that allows the organization to identify where they are achieving their objectives and at what points need to improve, they are the key to the organization to know where to go, or what planning should be done *“A plan has objectives that should be measured, answer to responses that stakeholders require, building options and contingencies, identifies and quantifies risks, defines how to minimize those risks or the adverse consequences that may arise from them and allows progress to be measured. In this perspective, planning involves managing, time to perform, commitment, cost, research and assumptions. Consequently, it is important to do well (or less badly than the competition) because it gives certainty, measurements, confidence, and a way forward for other of premeditation evidences.”* [9].

The Balanced Scorecard (BSC) is a model of a logic project for organizations management *“... Every organization must rethink the fundamental assumptions on which it competes. With the increasing connection of the global economy, every business should build their own feedback systems to effectively monitor their activities to achieve their strategic goals.”* [10]. This model allows for *“a new system of management for organizations to focus long-term on customers, employees, develop new products and new systems, instead of focusing only on short-term profit.”* [10] which provides the mechanisms needed to make the organization flexible and adaptable to the current global competition based on knowledge. Without identifying a set of interior or exterior organizational changes and without their quick adaptation to the new environment, the organization may lose competitiveness and obtain truly disastrous results *“Think of the BSC as the dials and indicators in an airplane cockpit. For the complex task of navigating and flying an airplane, pilots need detailed information about many aspects of the flight. They need information on fuel, airspeed, altitude, bearing, destination, and other indicators that summarize the current and predicted environment. Reliance on one instrument can be fatal”* [11].

## 2.2. The Zachman's Framework and the EX-ANTE and EX-POST Model

To develop the model presented in Section 3 is important to introduce the Zachman's Framework and the EX-ANTE and EX-POST model.

The Zachman's Framework is a network architecture for information systems [12] that offers 36 categories needed to describe something, especially something as complex as industrial products, or organizations. It provides 6 detailed views of different perspectives from different levels of abstraction for understanding EA, which creates an overview of the environment. *"Zachman explains his framework for information systems architectures by using an analogy to the process of planning, drafting, and building a new home. Thus he used the terms owner's view, designer's view, and builder's view for increasing levels of detail appropriate for the purpose."* [13] adding to each perspective *"the product of abstractions: that is what (material) is made of, how (process) it works and where (geometry) the components are relative to one another"* [12] and then *"the remaining primitive interrogatives: who (people) does what work, when (time) do things happen, and why (motivation) are various choices made?"* [12].

The EX-ANTE and EX-POST Model, developed by the Center for Organizational and Design Engineering (CODE), is an example of the framing of an essential tool with a scientific reference. This model aligns EA with the Enterprise Architecture Governance. The EA consists of four layers, Strategic, Business, Applications and Technological Infra-structural plus two additional layers, control, access and data security called EX-ANTE and auditing and monitoring called EX-POST *"In the current scenario, the concepts of flexibility and adaptability are directly applied to the organizations that need to monitor the changes in the environment in which they operate."* [14].

The model central structure is composed by the four layers listed above that aims to describe the elements of an organization and plans to standardize, integrate and enhance its automation for the operations of the organization. "The elements of the organization, considered in the architecture include:

- *Information management, for example: objectives and strategic indicators;*
- *Organizational elements, for example: people, skills, units;*
- *Operational elements, for example: flows, business rules and operating procedures;*
- *Applicational elements, for example: business services;*
- *Elements of the infrastructure."*

This model responds to the current need that organizations have to introduce technology that allows them to monitor their actions and verify that they are leading the organization to fulfil the strategy *"A successful organization identifies new technologies, introduces them quickly and sells them next. An organization that does not have this behaviour will be absorbed by a competitor. Thus, top managers require their employees to develop and implement an enterprise architecture that ensures a superior position over its competitors."* [14-16].

## 3. EX-ANTE and EX-POST Model application to SIGOP

This paragraph presents the PoAF organization, its actual functions and which functions need to be changed, based on the EX-ANTE and EX-POST model, in order to fill the control and operational analysis gaps, helping the organization to overcome the current vulnerabilities and raise levels of performance on the Mission. The section also presents the SIGOP.

### 3.1. *The Portuguese Air Force*

The Organic Law of the Air Force (LOFA) defines the PoAF's structure. Directed by the Air Force Commander the Organization entails the Headquarters (EMFA), which studies, concepts and plans activities, four Commands: Personnel (CPESFA), Logistics (CLAFA), Training and Formation (CIFFA) and Air (CA). The Finance Directorate (DFFA) assures the financial component [17].

The CLAFA is responsible for administering material resources, communications and information systems and infrastructure and for the implementation of plans and policies approved by the Air Force Commander. This body comprises the Direction of Communications and Information Systems (DCSI) and the Direction of Weapons Maintenance (DMSA) [17].

The CIFFA ensures the recruitment, education and training activities for personnel, in accordance with the plans and policies approved by the Air Force Commander. It holds functional authority over all education, training and instruction organs. The units of instruction depend on the CIFFA [17].

The CA is intended to support the exercise of command by the Air Force Commander, guaranteeing the preparation and support of forces and means of the operational component of the force system, the compliance with special missions approved, missions governed by specific legislation and other mission of operational nature, is also responsible for the planning, command and control air activity [17].

The LOFA defines also organs that are responsible for training, sustaining and generally support. The Air Units (AU) must ensure the air activity, the logistical and administrative support of units and subordinated organs [17].

### 3.2. *Integrated Operational Management Information System*

The SIGOP is a software application in which is inserted all the information relating to executed operation. Can be consulted in it any information concerning to any intervener on the operational triad. The operational triad is composed of three high-level elements related to mission of PoAF (Mission, Aircraft and Crews). These mission elements are interrelated and the aircraft readiness affects the fulfillment of missions and qualifications of crews. The qualification of crew affect the accomplishment of the missions and the failure of the missions affect the qualifications of crews. Data entered into SIGOP is transcribed from the physical document used in PoAF for operation performed registration and later consultation.

The planning to be introduced in SIGOP aims to create a reference system that will increase the operating capacity of management by the operating entities and to give organizational self-awareness. The missions assigned by the CA to AU aim to make possible the fulfillment of the mission superior assigned to PoAF. The EMFA is responsible to oversee planning/execution ratio compliance and develop, promote and monitor the implementation of operational doctrine. For the crews, it is the interest of top management organization to study and ensure the quantitative of personnel and staffing needs for the operation to succeed. The CA presents until the end of January the list of personal needed by each AU for the year. The CPESFA is responsible for the preparation of personnel and for the performance of the assigned tasks. For the aircraft, it is the interest of top management, to study the organization and ensure the air assets necessary to the operation. All the planning, including missions, necessary amount of personnel and aircraft readiness required to accomplish the stipulated tasks, should be introduced in SIGOP.

The research studied the different type of existing information and concluded that, to increase self-awareness, SIGOP should be modified allowing the following information to be present: i) planning data; ii) execution / planning accompanying dashboard; iii) customized reports.

The content of the following table shows the planning functions that are intended to introduce in SIGOP.

Table 1. Detailed Operation Planned for Mission, Crew and Aircraft [18]

	Why?	Who?	How?	What?	Where?	When?
Missions	Create a reference for the missions to execute	EMFA CA CIFFA	Calculation of FR for each AU	Information related with planned missions	SIGOP	Beginning of Operational Year
Crews	Create a reference of the number of crews needed	EMFA AU CPESFA	Calculation of the number of crews needed	Information related with planned crew	SIGOP	Beginning of Operational Year
Aircrafts	Create a reference of the number of airplanes needed	EMFA CLAFA	Calculation of the number of ready aircrafts needed	Information related with planned aircrafts	SIGOP	Beginning of Operational Year

### 3.3. Meta-Model

This paragraph presents the components used, in the context of OE, for the creation of the meta-model. The meta-model, shown in Fig. 1, is composed by two models: the EX-ANTE and EX-POST and Zachman’s.

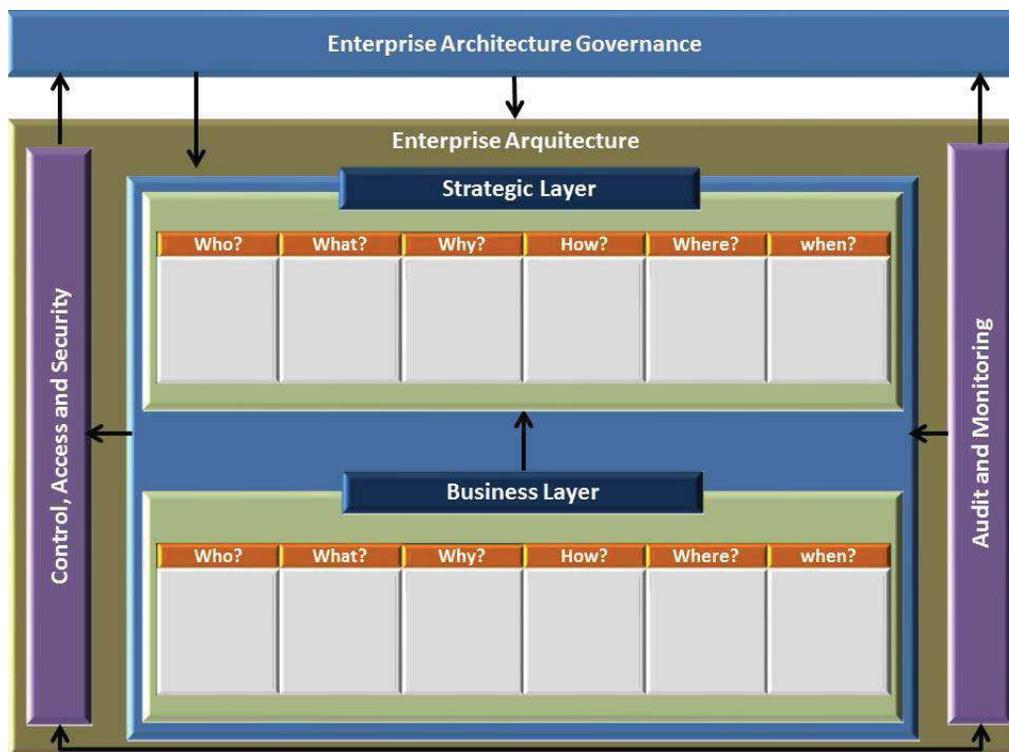


Fig. 1. Operational Management Meta-Model [18]

For academic purposes the level of EA is focused only in the “Strategic layer” and the “Business layer”, all other components of the EX-ANTE and EX-POST remain. The lines of Zachman’s Framework remain unchanged.

The layer of government is primarily committed to EMFA, which coordinates, with the different commands and directorates, a set of responsibilities and practices that provide the strategic direction of the organization ensuring that targets are set, and the resources to achieve them are secured. It is the responsibility of the CA / CIFFA to define the operational and educational objectives ensuring control of the AU operation, if they have at their disposal the necessary resources as well as appropriate tactical planning for the achievement of operational and instruction objectives. In the final analysis, the AU are the execution bodies and have the responsibility to develop operations that fulfill the operational objectives defined. However, it is up to EMFA to oversee the operation ensuring that the guidelines are appropriate, in accordance with the organization strategic interest and to provide guidance to the different organs so that operational objectives are realized.

Policy is defined in the Control, Access and Security layer. This layer is transversal to SIGOP users and allows: i) users to access data according to the authority given; ii) defining user reading, writing and updating privileges, depending on the entity; iii) changing security levels of information; iv) recording all transactions made through a date and time registration; v) defining the allocation of control passwords of different users.

This layer also defines: i) the way to access the data contained in SIGOP and the way each user, depending on the security level, access data and displays; ii) the policy of quality assurance by monitoring and enforcement mechanisms to ensure fewer errors and system failures.

In this article, these specifications are generally defined by instantiating the meta-model. The auditing and monitoring layer is committed to DCSI to ensure the storage, traceability and data integrity.

#### *3.4. Meta-Model Application*

The strategic layer describes the goals and objectives of the organization and the business rules and regulations that define the operational management. The EMFA, situated in the strategic layer, defines the business rules translated into policies that guide the different Commands in their roles. The Mission Annual Planning (MAP) is developed by EMFA and approved by the Air Force Commander. The EMFA is capable of introducing the MAP so as to change it when needed.

In the business or operational layer, fit into three entities that will be presented separately. CA and CIFFA define and control the air activity and operational instructions and the AU executes the air activity. This layer describes how the PoAF conducts its operation and how resources are used to achieve the strategic objectives.

The CA and CIFFA, at the operational level are responsible for issuing mission orders and courses respectively, defining operational objectives that are adapted to the reality of the organization and that they remain aligned with the goals defined superiorly. It is the responsibility of these entities to disseminate information to guide the AU in its operation, as well as control its operation.

The AU, at the tactic level are responsible for defining business processes that enable them to utilize the available resources with maximum effectiveness and efficiency ensuring the accomplishment of the planning defined superiorly.

The combination presented in the meta-model allows the creation of the precondition for the introduction of a MAP and its amendment when necessary, the inclusion of execution data in the application through the mechanisms of EX-ANTE, storage and data consult in accordance with the principles of BI through the mechanisms of EX-POST. EG is present throughout the model governing the rules by which those involved use the application. This meta-model allows the introduction of data necessary for the construction of an operational cockpit, visible through a “Dashboard”, which permits the development of an operational BSC to

monitor and analyze the operation through the defined KPI. The meta-model allows the creation of “Means” needed to achieve the “Ends” at the level of operational management, in accordance with the BMM.

In the final model, shown in Fig. 2, four entities are divided as follows. In the strategic layer, the EMFA assigns the MAP, oversees the operation, and assigns corrections as necessary. The remaining entities are assigned to the operational layer (business), as well as the CA and CIFFA have levels of operational management of direct control over the operational and instructional AU respectively. The AU, whose function is linked only with the implementation of MAP, represents the core of operational layer. As result of the work done in the previous sections we obtain the following model instantiated (EA instantiated, the rest of the meta-model remains unchanged).

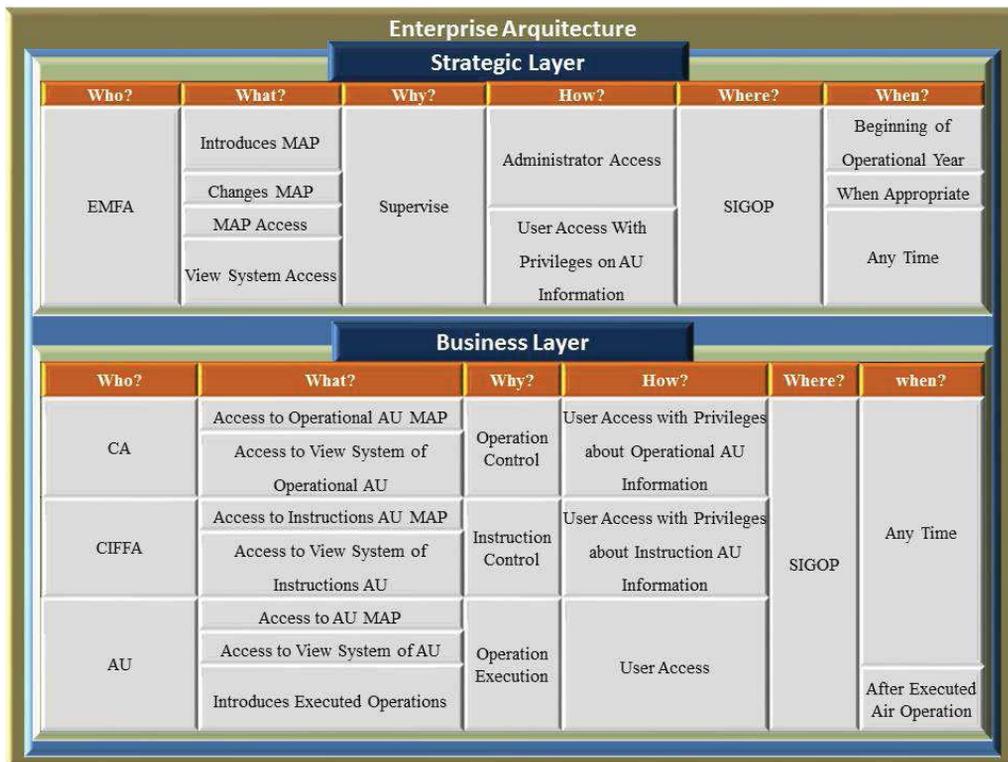


Fig. 2. Portuguese Air Force Operational Management Model [18]

### 3.5. View System

The view system includes the operational “Dashboard” to be inserted in SIGOP. This serves to show the user the desired information in a time interval of the relationship between the operations planned and performed for each component of the operational triad. The privileges of access, amendment and registration data are defined in the model presented.

For the mission is important to note that planning should address the different Modality Type (TMOD) [19]:

- TRU – Standardization Training;

- TRM – Qualification Maintenance Training;
- OPER – Operating;
- INST – Instruction;
- TRQ – Qualification Training.

The relationship between data and planned implementation might infer the Performance Indicators for the total FR and by TMOD, for ready Aircrafts and qualified Crews. The relationship of each performance Indicators by AU causes the performance of AU and its relationship in the overall level results in the overall performance of the organization at the operational level.

For the Air Force Commander, the view system must also incorporate a mechanism for maintaining financial control, visibility and financial support of the implementation, in a way that can be made the update planning in time. It is therefore defined a planned cost of the planned FR that identifies the budget necessary to implement the plan and a parameter of budget used that identifies the budget that was spent for the implementation of the FR.

### 3.6. Model Validation

Through the validation is intended to judge if the designed model is adjusted to the organization, for it is carried out a test in order to measure whether the result of research work is aligned with the operation (business) of the Organization.

Under the research, using the same principles as those developed in this work, a prototype dashboard was developed. The tool gathers planning and execution data and monitors the operational activities. This first version of this tool has been used since the last trimester of 2009 and suffered several improvements. The results show an increase in organizational self-awareness which is reflected of the ratio between operational planning and execution. According to the Statistical Yearbook, 2011 of PoAF, there is a meaningful increased level of efficacy in the year 2011, relating to the fulfillment of the number of FR, aircraft ready and crews qualified.

Data from the Statistical Yearbooks, 2007 to 2011, reveals:

- Number of Hours of Flight: 85% - in 2007, 94% - in 2008, 94.5% - in 2009, 97.9% - 99.8% in 2010 and 2011;
- Aircraft Readiness: 58% - 2007, 72% - 2008/2009, 76.9% - 84.5% in 2010 to 2011;
- Qualified Crews: 75% - 2007, 61% - 2008/2009, 75% - 2010 to 98.3% in 2011.

These results show a real example of the impact that implementation of this new integrated management tool can bring to all levels of operation.

## 4. Conclusion

Based on theoretical knowledge, it was possible to use the 'Zachman's Framework' and 'EX-ANTE and EX-POST' model, to create the meta-model to solve the lack of a reference system at the operational level in PoAF. In order to apply the meta-model designed to the operational management of the organization reflected in SIGOP, it was done the integration of the different models, ending with the final solution, originating the requirements for changes to develop, to SIGOP, allowing the following information to be present: i) planning data; ii) execution /planning accompanying dashboard; iii) customized reports. The result is the creation of a conceptual SIGOP adapted to the current operational needs of the organization, including planning of missions, available to different entities involved at the strategic, operational and tactical levels. The planned

versus executed comparison information allows the analysis of the operation and calculation of performance indices, culminating in the preparation of an annual report that demonstrates the development of the entire air operation against the plan. This data analysis and calculations of performance indices allows the continuous adjustment of planning to meet current operational needs.

The research used the following concepts and theories: EO in an attempt to make people more aware, the BSC concept to design the dashboard, the KPI concept to define important information to be known, EG to rule the meta-model and influence the entities actions and EA principles, applied to the EX-ANTE and EX-POST and Zachman models, to develop the meta-model itself.

However, this work does not solve the problem, so it is needed to be developed and implemented the software necessary for the development of this tool with the technological tools available, as well as developing the appropriate business rules to implement the new changes. It will be necessary to spread to stakeholders and users of the application, which changes were made, so it is suggested a method for implementing the new SIGOP, which may go through training initiatives and the development of user manuals that may be available on time.

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