

TicAPP – Digital Transformation in the Portuguese Government

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Abstract

Currently, governments are developing or implementing digital transformation approaches addressing citizens' unmet needs from public services. In order to enable this transformation process Digital Centers of Excellence (DCoE) have been created. They promote best practices and standards to be used across organizations to increase coherence, reduce duplication points and develop people capabilities through training and education. One main issue when creating one DCoE is how to implement them to be sustainable, competitive and able to deliver projects efficiently and cost-effective. This work assesses similar centers implemented in different countries to gain an understanding on how they operate. We identify their common goals, drivers and services. A reference enterprise architecture for DCoE is proposed in this work. Regarding the business architecture 4 products were identified: Data Science, People, Technology and Digital Transformation. These are comprised by a set of services. Crossing them with the center business functions the research proposes 21 business processes. After identifying the interactions the center has with stakeholders, 14 information entities are proposed. The application modules necessary to support the business were identified through a CRUD matrix. This resulted in 7 different modules. Market solutions were researched to realize the modules identified. Finally, the paper proposes a technology infrastructure, based on cloud, to support the applications suggested. The architecture is instantiated to the case of the Portuguese Public Administration, in the DCoE ticAPP. After setting up the architecture, the benefits of the architecture for ticAPP are evaluated. The evaluation shows the enterprise architecture was correctly identified and fits its purpose. The results support that the overall Enterprise Architecture is a key component and an important artifact for continuous improvement.

Keywords: Enterprise Architecture, Public Administration, Digital Transformation, ticAPP, TOGAF, Digital Center of Excellence

1. Introduction

1.1. Context

The creation of a Digital Center of Excellence was motivated by a shortage of IT human resources, spread across the Public Administration, along with an aging workforce. Additionally, Public Administration staff's knowledge-base has not been reviewed for the Digital Transformation process it is going through. We collected statistical data from about Public Sector employment from DGAEP (Direção-Geral da Administração e Emprego Público) and found that, within IT, there is shortage of people. There are approximately 5.000 people working in IT in the Public Administration [2], out of the 669.000 currently employed, roughly 1% of the Public Administration workforce. This means, despite Portugal being close to the European median, in terms of digital competences, it needs to reinforce basic ICT skills, especially its human capital [5]. We searched within IT how

the age group is distributed. Most IT workforce of the public sector is between 34-54 years old. This means recent graduates and young people, between 24 and 34 years old, are not currently attracted to opportunities in the Public Administration. Next, we observed the distribution of the resources across the Public Administration. and most resources reside within Central Administration. They are distributed by the several Ministries, stressing the point of resources being distributed across several public organisms. Lastly, we collected information concerning the education level of IT personnel across the Public Administration. About 43% holds the 12th Grade, or equivalent degree attained from a professional school for instance, while 38% hold Bachelor (Licenciatura) degree on IT. This means the majority of people in IT have the essential skills to engage in IT projects, but few are specialized (Only About 200 people hold master's degree).

1.2. Problem Definition and Contributions

A Digital Center of Excellence (DCoE) is, usually, a small team that supports an organization in a particular field. It can range from supporting project management to assisting the design and implementation of solutions. It is necessary to understand what are the services a DCoE offers to support their strategy. This means knowing what are its business processes and what information do they manage. Therefore, the problem we want to address is *How can a DCoE be implemented in a sustainable, competitive and able to develop cost-effective and efficient projects*. More specifically, this research addresses:

- What is the business strategy of a DCoE?
- How should a DCoE organizational structure be?
- What are the business services delivered by a DCoE to implement the strategy? Which business activities and processes are necessary to realize those services?
- What information is collected, generated and managed by the activities of a DCoE?
- What custom or off-the-shelf application software a DCoE requires to support the business and store, distribute and manage information.
- How should the technological infrastructure of a DCoE be implemented to run the application components?

Having an Enterprise Architecture, contributes for Digital Centers of Excellence to define their current and future strategy better and to work effectively with other Public Administration departments. This reduces costs, risks and unnecessary effort in project development, rendering the center competitive, and able to achieve current and future objectives.

The objective of this work is to contribute for the effective operation of a Digital Center of Excellence. Therefore, this thesis aims to contribute with a way of developing an Enterprise Architecture that can answer the questions made previously. This will enable the Centers to understand better what their capabilities, functions and relationships are and ensure that projects are successful and delivered in an agile, adaptive manner. Therefore, the architecture has to provide a broad view of the Digital Center and clearly communicate how it conducts business. The architecture must meet business strategy and vision of the DCoE and be adaptable to change during the life cycle of the DCoE, as their business requirements might change over time.

1.3. Research Methodology

The methodology chosen to support this work was Design Science Research. It focuses on developing knowledge and understanding through building and evaluating artifacts. These are designed to address problems on a particular domain [4]. It is most notably used in engineering and computer science research projects. There are six-steps for this methodology:

1. **Problem identification and motivation** – Define a research problem and explain its relevance. This was already identified in the previous section, along with the next step.
2. **Define the objectives for a solution** - The second step is to identify what are the objectives the solution attempts to accomplish and what knowledge can be derived from it.
3. **Design and development** - The third step is to create an artifact. This dissertation focuses on methods and instantiating them in a real case. To design our solution, we researched general, accepted methodologies, to design enterprise architectures. We identified their advantages and weaknesses and propose an adaptation. In chapter 3 we describe the method used to design the enterprise architecture of a Digital Centre of Competences and in chapter 4 we apply it in ticAPP Digital Center of Excellence.
4. **Demonstration** - The fourth step is to demonstrate the use of the artifact by applying it in one or more problem instances. In this situation, we will be instantiating our enterprise architecture design to the Portuguese Public Administration DCoE ticAPP.
5. **Evaluation** - Verify and assess to what extent the artifact developed address the problem defined how well the artifact supports a solution to the problem.
6. **Communication** - Communicate the problem and its relevance and how the artifact developed is new and useful in its application solving the problem, the artifact, its utility and novelty, the rigor of its design and its effectiveness to researchers and other relevance audiences such as practicing professionals, when appropriate.

2. Digital Center of Excellence (DCoE)

A Center of Excellence is, usually, a small team that supports an organization. They are built around a specific knowledge area, relevant for the organization and of particular importance for the

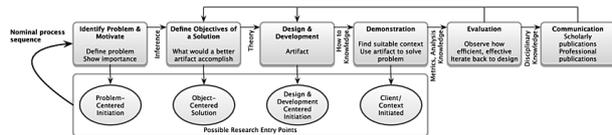


Figure 1: Design Science Research Methodology - [4]

business (e.g Big Data, Business Process Management, Software Development). Their main objectives are to:

- Define best practices to be used across the organization
- Define standards and promote the use of shared applications, processes, data and business functions to increase coherence in the organization
- Identify and reduce points of duplication of effort across the organization
- Training and education

Implementing a Center of Excellence in an organization results in improved consistency and better IT and business alignment [1]. In the following section, we present three cases of Digital Centers of Excellence in the Public Sector. They were chosen due to their impact on transforming their governments, by enhancing the operation of the public administration services.

2.1. UK GDS

The Government Digital Service (GDS) is a centre of excellence in digital, technology and data, part of the UK's Government Cabinet Office. It is assigned to support the digital transformation of government. It supports the development of platforms, standards, and digital services and contributes to improve citizens' relationship with the government. GDS is investing to improve the government data science capability for effective and accurate data-driven decision making and use of data [GOV.UK, 2018]. GDS is also responsible for ensuring that the departments have the necessary digital capabilities for their digital transformation process. Therefore, they have a Digital Academy with various courses to give government the capability to continue to improve digital services.

2.2. Italy Team Digitale

The Digital Transformation Team (Team Digitale) is a DCoE organized to create a new, more effective, Italian Public Administration. It builds services based fundamental blocks, where the services for businesses and citizens and the Public Administration itself are developed [TeamDigitale, 2018]. The team is composed of 29 experts with management and technological skills, namely software

engineering, open source software, cybersecurity, digital payments, product and content design, user experience, big data and data science.

2.3. Singapore - CentEx for ICT

Part of the Singapore Digital Strategy is the creation of capability centers. These Centers of excellence comprised specialized areas of IT (data scientists, analysts, developers and engineers), gathering experts in each domain. By doing so the Public Administration they internalized knowledge and human resources with the specialized technical skills in an in-house pool of resources able to take on innovative projects across the Government. The center embraced five areas of expertise, namely Sensors and IoT (Internet of Things), Data Science and Artificial Intelligence, Application Design, Development and Deployment [SmartNationSG, 2018]. The Singapore Strategy aims for digital services that meet citizens' needs, available through any device. This means the citizens must feel confident and assured their data is secure with the government. They legislated data sharing and safeguards in the public sector, allowing data to be shared in a safe and responsible way.

2.4. Comparative Analysis

The digital centers of excellence introduced are collaborating with Government Departments to help them in their transformation process. They act as an in-house reserve of deep technical skills in areas where internal capabilities are needed. The three case studies have similar strategies, with great focus on the following objectives. On the one hand, to support the government in digital transformation by investing on cross department architecture for their platforms and enforcing standards on how to develop services and source for technology. The DCoE are also expanding the digital capabilities of public officers by delivering multidisciplinary training. All centers are attempting to leverage data to support the public bodies in making the best and most data-driven decisions, adopting big data and machine learning techniques. They also collaborate with public services to deliver seamless, simpler and secure services to citizens, investing in once-only policies, to minimize the frequency citizens are requested the same information across public bodies, with the help identity verification platforms (Singapore's MyInfo, Italy's SPID and UK's gov.uk Verify). On the other hand, the DCoE are redesigning citizen-facing services. Using Agile methodologies, they focus on meeting the citizen needs to build better public services. Italy is extremely focused on accessibility. It is following the mobile-first principle. This means government services are designed so citizens can access them at any time at their mobile device. Even in different lo-

cations (Singapore - Southeast Asia, Italy- Southern Europe and the UK - Northern Europe) with different political settings, these centers of digital excellence are currently working on the same issues, using identical approaches. Figure 1 represents a quadrant summarizing the scope and domain of IT and its application across the Public Administration or in each sector:

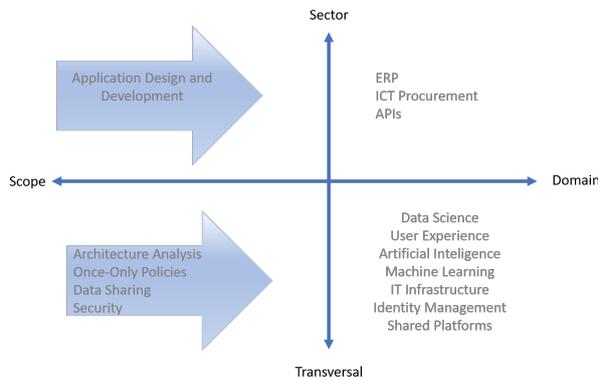


Figure 2: Transversal vs Sector Application of Digital Transformation in the Public Administration

Considering the comparative analysis and the previous figure these are aspects the Digital Centers of Excellence for the public sector analyzed here share:

- Their main stakeholders are the citizens, businesses, the Government departments and public officers.
- For citizens and business, the main objective is to enhance the relationship with the Government. This is achieved by helping to design simpler, accessible and easier to use services by applying service design standards that cover all available services. This increases coherence while navigating through different services, promoting a better user experience.
- For the Government Departments, the DCoE support their digital transformation process. By developing the cross-government services hosted on a shared platform (Government as a Platform), DCoE increase the efficiency of the Government by making an effective management of data and reducing the number of duplicate systems. They are also helping departments designing services by providing a set of standards and best practices and advising on how to make the best decisions regarding technology procurement.
- For the public officers, the DCoE are aiming to expand and deepen their digital capabilities through training.

3. Proposal

The main goal of this thesis is to build a Reference Enterprise for Digital Centers Of Excellence to contribute for sustainable operation, make them competitive and capable of delivering projects consistently, efficiently and cost-effective. This method followed a top-down approach for building the reference Architecture, with Strategy, Business and Information as the main pillars of this work.

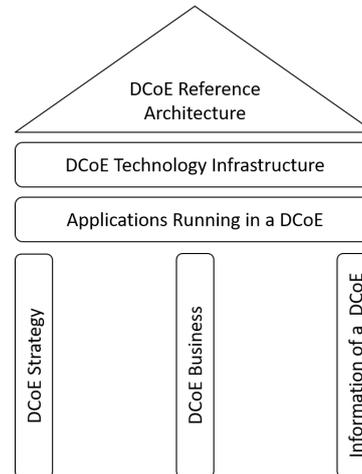


Figure 3: DCoE Reference Architecture Pillars

The objectives are listed below:

- Collect and analyze information about existing centers from existing documentation. Go to the industry to find additional information if the one found is not enough.
- Identify common characteristics between the Centers and
- Based on the common characteristics, build the Enterprise Architecture in a top-down approach.

3.1. Strategy for a DCoE

After analysing each center information individually, we need to compare the DCoEs in order to find common concepts between them. From the DCoEs we have introduced in chapter 3, they considered these stakeholders:

- Citizens and business – The Centers want to deliver more simple, want to deliver User-Focused, digital services that meet the needs of these stakeholders
- Government departments and public officers - Increase the efficiency of the departments and enable digital. Regarding goals the Centers wants to encourage the Government Departments to adopt shared platforms to reduce duplication points. It defines best practices and

standards on how to develop software, managing data. They also aim to leverage Big Data for data-driven decision and accurate insights.

Therefore, the strategy for a DCoE should consider the aspects mentioned above. The main driver for DCoE should be Digital Transformation. This can be split in Innovation, Simplicity and Efficiency.

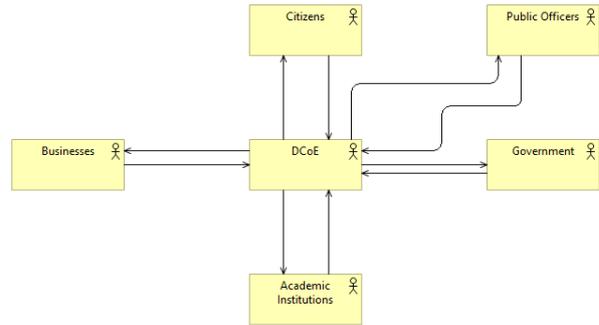


Figure 5: Reference Business Context for DCoE

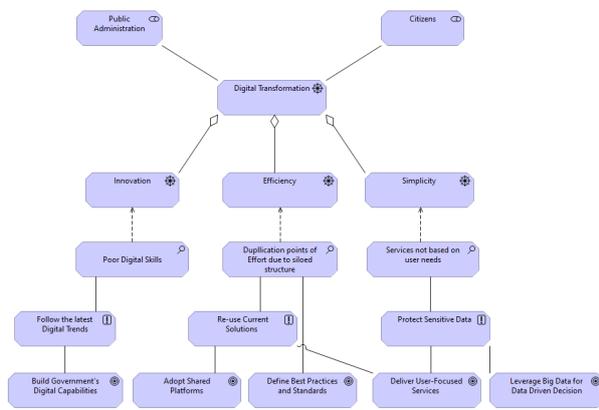


Figure 4: Reference Strategy for DCoE

3.2. Business of a DCoE

In the business layer, we focus on DCoE structure, the services it provides and the business process required to support them. To help identify the aspects above, we can use a business context diagram. It provides visual representation of relationships among business key players of the Center. It helps to understand more about business functions, processes and outcomes. Thus, it also provides excellent input to build the Information Architecture later on. Every actor, message, subject, and event in the context diagram will become an entity, or an attribute, when designing the Information Architecture. And, since all actors and subjects are related to the organization business model, the context diagram is validated for the organization's scope [9]. Therefore, the business context for a DCoE can be described as From the information we analyzed, we identified common services that DCoEs to realize their strategy

3.2.1 Process Architecture

To realize the services of the DCoE, we need to identify a set of Business Processes to support

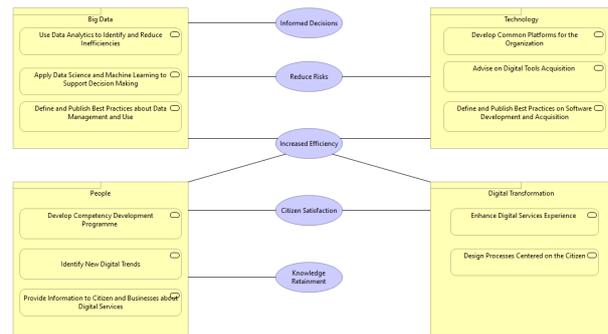


Figure 6: Reference Services for DCoE

them. Therefore, we can build the DCoE process architecture, using the case/function matrix, a Business Process Management tool. According to Dijkman [3] the approach to build the matrix consists of four steps: Identify Case Types. In the context of this work the most suited are the services that a DCoE delivers. Identify the business functions that are required for the different case types. Build the matrix and apply Dijkman rules to split big processes into smaller, more specific ones.

	Provide information to citizen and business about digital services	Use data analytics to identify and reduce inefficiencies	Apply data science and machine learning to support decision making	Define and publish best practices about data management and use	Develop competency programs for the organization	Advise on digital tools acquisition	Define and publish best practices about software development	Enhance digital services experience	Design processes centered on the citizen
Client-Citizen Relationship Management	Provide information								
Case registration and analysis		Use data analytics to identify and reduce inefficiencies		Define and publish best practices about data management and use					
Data Protection									
Data science									
User Experience									
Business Process Management									
Software Development									
Operational Excellence									
Customer Relationship Management									
Digital Academy									
Administrative Management									
Finance & Accounting									
Human Resources Management									

Figure 7: Reference Business Processes for DCoE

Using Porter Value Chain Model [8], we can depict the set of activities performed by a DCoE to deliver value to the client. The model divides primary and support activities. The first are considered essential for value creation and are divided in five activities. Support Activities assist primary activities on value creation.

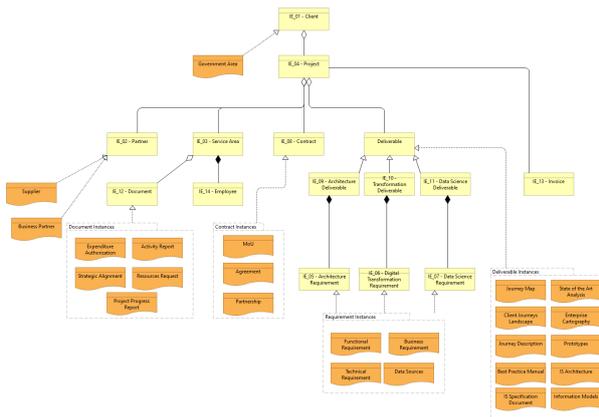


Figure 14: ticAPP Information Model

5.1. Contributions

The main contributions of this work are related to questions in Chapter 1 and the objective the proposal was set to meet. Therefore, it is important to relate these two aspects.

- What is the business strategy of a DCoE? The approach we used to build the reference architecture started by collecting information about similar DCoEs and attempting to identify common aspects about them. Most of these aspects were related to the goals, drivers, vision and mission of the center. Therefore, we had enough elements to produce a reference strategy for DCoE, hence this objective was met.
- How should a DCoE organizational structure be? Again, from the Centers analyzed, although the structure were different, in size and how the center was organized, they were working on the same scope, which made it easy to find the necessary business functions of a DCoE.
- What are the business services delivered by a DCoE to implement the strategy? Which business activities and processes are necessary to realize those services? We had to identify the services the DCoEs analyzed delivered. By crossing that analysis with business functions, we were able to in the method followed for the business layer ??, to build a matrix where following a set of rules, we were able to define reference processes for a DCoE
- What information is collected, generated and managed by the activities of a DCoE? Through the business context diagram, we were able to describe the interactions (messages) between DCoEs and its stakeholders. From the information they exchange, we were able to derive relevant information entities that a DCoE should manage. This objective was also met.

- What custom or off-the-shelf application software a DCoE requires to support the business and store, distribute and manage information. Following the approach to build the application architecture, we took the information entities and the business processes, and built the CRUD matrix that allowed us to identify which application modules we-re necessary. Although, we did not mention market applications for our reference architecture, the demonstration case presented market options that should be considered to support the business.

- How should the technological infrastructure of a DCoE be implemented to run the application components? Finally, this objective was also met, where we also present a reference technology infrastructure based on the cloud, that is being followed by many organization, due to the advantages it brings.

Overall, we can conclude that the questions raised in this thesis were answered. The questions that map directly to the pillars 3 of the proposed reference architecture, we able to be answered with greater detail, while the last two were derived from their outputs. There were also some limitations we identify later in the conclusions.

5.2. Proposal Evaluation

Regarding the resulting reference architecture, we verified if it follows the alignment in the Business, Information and Application Domain. Therefore we applied the Alignment Heuristics[7], introduced in chapter 2.

5.2.1 Business and information Alignment

- All business processes activity create, update and/or delete at least one information entity.
- All information entities attributes are read at least by one business process activity.
- All information entities have an identifier understood by business people.
- All information entities must be classified and named within the Information Architecture.

If we look at the CRUD Matrix (Figure ??), we can conclude the first 2 aspects were covered. The last two aspects are validated through the Information Architecture diagram, along with the table that describes them. Each Information Entity was named, having a set of attributes characterizing them.

5.2.2 Business vs Application Alignment

- Each business process should be supported by a minimum number of applications. This simplifies user interfaces among applications, reduces the need for application integration, and also minimizes the number of applications that must be modified when the business process changes.
- Business activities should be supported by a single application. This reduces the need for distributed transactions among applications.
- Each application's functionality should support at least one business process activity. Otherwise, it plays no role in supporting the business. The CRUD Matrix, shows we were able to identify the application clusters necessary to support ticAPP's business. Furthermore, the modules identified have no dependencies between them, thus enforcing the third aspect.

5.2.3 Information vs Application Alignment

- An information entity is managed by only one application. This means that entities are identified, created and reused by a single application

Analysing the CRUD Matrix again, we can conclude that this heuristic is met. Since there are no dependencies between application modules, they do not share information entities.

5.3. Evaluation of TicAPP Enterprise Architecture

5.3.1 Comparison with other Digital Centers of Excellence

In chapter 3, we introduced three case studies of DCoEs implemented in different Governments. These digital centers of excellence all collaborate with the respective Government Departments to help them in their transformation process. Their main services are to collaborate with departments to build platforms, standards, guidelines and best practices and digital services, and to reshape public services, based on citizen needs. TicAPP's mission is to support government areas in their digital transformation process and to improve the quality of public services available to citizens and businesses. Through common, cross-government platforms, best practices and better use of data they contribute for government departments to be more efficient. Through User Centric Design and Agile methodology, they can deliver better services to citizens and businesses, focused on their needs. Considering these points, the enterprise architecture developed for ticAPP is aligned with the other centers, namely regarding strategy and business.

However, services like the expansion and deepening of digital skills through an academy, like the GDS Academy or other facility, are out of their scope at the current time. They do provide. From all the centers analyzed we can also conclude that TicAPP is most similar to Team Digitale in terms of team structure and size, and scope of operations.

5.3.2 Evaluation with Stakeholders

The project was followed by ticAPP's team, where periodic meetings were held, to check the progress of the architecture. From the feedback provided, we were able to make the necessary adjustments and corrections to the viewpoints generated for the architecture. To understand how beneficial was the Architecture developed for ticAPP, we conducted a survey, featuring answers from the ticAPP team. The survey questions cover the architecture layers addressed in this work, and were based on other scientific projects, that developed a method for evaluating enterprise architecture artifacts[6]. The questions covered the 4 layers of the architecture - Business, Information, Application and Technology, how they are related and if they aligned with the expectation of the team. We used a Likert Scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). For every answer we calculated the average mark and summarized the results in the following chart:

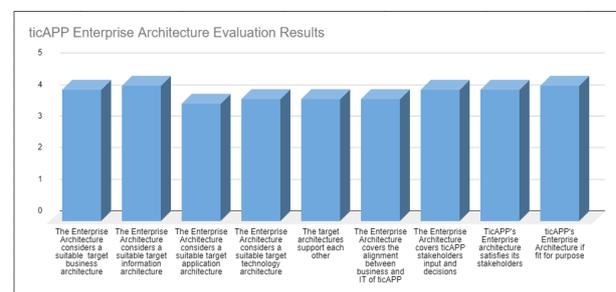


Figure 15: TicAPP EA Evaluation Results

Our analysis of the survey data identifies key points about ticAPP's team perspective about the architecture developed:

- More than half of the respondents agreed the ticAPP business strategy was correctly identified. This enables us to conclude the viewpoints selected were suitable to characterize the business strategy of the DCoE.
- The TO-BE business architecture and information architecture are suitable and correctly identified according to the respondents.
- Both the target application and technology architecture generated mixed responses. From

additional feedback obtained from team elements, they considered some applications were missing, namely development tools. The application viewpoint was then updated to integrate the feedback given. The technology infrastructure seemed confusing for some elements, however this was later clarified.

- TicAPP's Enterprise architecture in general satisfied the stakeholders and was considered to be fit for purpose. From additional feedback, team elements also recognized the overall Enterprise Architecture to be a key component for the DCoE, representing a stepping stone in its creation and an important artifact for continuous improvement of the ticAPP.

During the development of the architecture, there was greater focus on defining the three pillars identified in our method - strategy business and information. The survey reflects this situation, with these architecture layers achieving higher marks, when compared the layers concerning the application and technology of ticAPP. The ticAPP team recognized the Enterprise Architecture was not only useful to map their strategy, organization, processes and supporting technologies, but also for building a future quality management system. From their input, we can consider the architecture to be fit for purpose. With this evaluation process, we conclude that the objective to contribute for the effective operation of a Digital Center of Excellence, through the definition of an Enterprise Architecture has been accomplished.

6. Conclusions

The objective of this work was to contribute for the effective operation of a Digital Center of Excellence. To answer this problem, there was a need to develop a reference Enterprise Architecture for DCoEs. The research process began current implementations of DCoEs and finding similarities between them. This allowed us to understand what are the common drivers, objectives for a DCoE and services they are currently providing. Our proposal consisted on developing a reference Enterprise Architecture for DCoEs. The resulting architecture comprised the EA core layers: Business, Information, Application and Technology. We then instantiated our method to the case of ticAPP, a DCoE implemented by the Portuguese Government. The contributions of this work are one hand academic, as the Enterprise Architecture can be subject of reviews, extensions, corrections or adapted for other domains. On the other hand the results presented integrated in a real organization, illustrated a successful adoption of the Enterprise Architecture.

A paper realized in Instituto Superior Técnico, Uni-

versidade de Lisboa has been published and accepted ICEIS 2019 : 21st International Conference on Enterprise Information Systems. It was presented in May 2019 where this work's solution proposal, although still in the very early stages of its development was addressed. Additionally, this document makes up a new component for the scientific community, to study and work on in the future. Although the work developed was able to contribute to the development of enterprise architecture for DCoEs, it is important to point limitations that occurred during its development. These relate to decisions taken during our work, and time restriction associated with the thesis. One of the limitations is the insufficient Enterprise Architectures about Digital Centers of Excellence, and more specifically on Public Administrations. Most information is found in written documents by the Centers and had manually analyzed to find similar concepts between the different implementations. Also, the scope of the information covered mostly the business and strategy layers. Another limitation was that the DCoE we were working with ticAPP was new, meaning it had no previous enterprise architecture. Therefore, the focus of this thesis began shifting towards implementing its Enterprise Architecture, instead of the solution's proposal refinement .

Overall, we consider our work a solid methodology to develop Enterprise Architectures for DCoEs. It takes information from similar implementations and tries to define the essential concepts to then model the enterprise architecture by its layers. However, we also think this methodology has great margin for improvement. There are some research opportunities, having this thesis serving as its basis to be considered. The limitations evidenced above can be directly linked to possible improvements for future work.

- Refinement of the reference architecture - The reference architecture can and should be subject to constantly refine it for improvements. As DCoE business requirement may change over time, it is important to keep the reference architecture up to date.
- Developing evaluation metrics for the architecture – In this work we used the Information Systems Heuristics developed by [7] to ensure the architecture produced was aligned at the Business, Information and Application Dimensions. Next, based on a work developed [6] to evaluate enterprise architectures we surveyed the ticAPP team to assess whether the architecture produced was fit for purpose. We consider additional metrics should be developed, such as checking for anti-patterns in the archi-

ecture.

- Instantiating this method to other industries – In this work, we instantiated the proposed method to the Portuguese Public Administration. The evaluation realized based on the results of this instance. Therefore, in order to better validate and evaluate the proposed method, it should be considered for future work to instantiate it to Digital Centers of Excellence in other industries. This will contribute to validate and improve the reference architecture.

In conclusion, this research work can add value to future projects, integrated in similar contexts of Public Administrations setting up these kind of Centers.

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