

# ticAPP – Digital Transformation in the Portuguese Government

Francisco Miguel de Lemos Santos<sup>1</sup>, André Vasconcelos<sup>1,2</sup>, José Tribolet<sup>1</sup> and Pedro Viana<sup>2</sup>

<sup>1</sup>INESC-ID, Instituto Superior Técnico, Lisboa, Portugal

<sup>2</sup>AMA - Agência para a Modernização Administrativa IP, Lisboa, Portugal

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

**Abstract:** IT is fundamental to digital transformation. Digital transformation focuses on driving the organization to a new level, exposing and extending its processes beyond the organization. Enterprise Architecture provides the tools and methodologies to manage the complexity of Digital Transformation. A Digital Center of Excellence, named ticAPP, is going to be assigned to support the Public Administration's Digital Transformation process. This paper focuses on building the future state Business Architecture of ticAPP, and how to enable its continuous evolution. We need to ensure the future state of ticAPP is not confined by the technology used and that it takes into account both Government's and ticAPP's strategic goals. To accomplish that, we follow a Top-Down Design approach development of ticAPP's Business architecture, based on TOGAF ADM methodology. In the final steps, we will evaluate ticAPP's maturity level using the Architecture Capability Maturity Model framework that is included in TOGAF and calculate its maturity rating.

## 1 INTRODUCTION

### 1.1 Context

The Portuguese ICT Strategy (CTIC, 2017) acknowledges that, IT in the Public Sector has become a bigger challenge than just going paper free and process automation. It must simplify the way citizens and businesses interact with the Public Administration. New concepts introduced in the IT environment, such as Data Science and Artificial Intelligence, enable a deep transformation process within the Public Administration. One of the key transformations is designing services, focused around citizens and businesses (CTIC, 2017). On the one hand, citizens expect public services to be simpler, easy to use and to access, through mobile devices. Information about a subject should be presented at one location, to avoid wasted time navigating through numerous portals, which are still in place in the Portuguese Administration. It would also be desirable to submit information once, and it being updated across the necessary information systems (CTIC, 2017). On the other hand, the Public Administration has a vertical structure, that creates information silos. To prevent that situation, the Portuguese ICT Strategy promotes the cooperation across the Public Adminis-

tration, in order to develop cross-functional services efficiently. A central challenge of this strategy is the need to account for the reinforcement and sharing of digital skills. Sharing between public bodies avoids redundant platforms and unnecessary portals, cutting back on costs and wasted resources. One measure of this strategy and stated in the Council of Ministers document, a Digital Center of Excellence (Portuguese Council of Ministers, 2018), named ticAPP will be created. It will operate under the supervision of AMA I.P (Agência para a Modernização da Administração Pública). It supports public entities in their digital transformation process, by retaining knowledge and skills within the public administration. It supports the solutions design for the public services, publishing guidelines and best practices documents on how to develop web applications for the government. This increases coherence across public administration web portals. It will revise the information systems architecture currently in place, contributing to clearly defined and accurate external contracts and increased efficiency and efficacy.

### 1.2 Problem Definition

Literature about other Digital Centers of Excellence, show that they share similar strategic goals and per-

form the same activities. Our problem is how to design ticAPP business architecture, and how it can act as a reference architecture for other Centers of Excellence in Public Administrations. Our goal is to develop an artifact for a consistent approach on how to implement a Digital Center of Excellence. It must be a flexible architecture to allow the integration of new services and must identify the necessary business elements: organization structure, processes, strategies, products, policies, initiatives, and stakeholders. Enterprise Architecture can help us to understand the current scenario of an organization, through *as-is* views, and what its target state should be, through *to-be* views. Typically, when aiming for a *to-be* model of the organization, a top-bottom approach is used. This ensures the future state of the organization is not confined by the technology used and that the solution can be traced back to the strategic drivers placed. TOGAF framework focuses on strategic alignment, between Business and IT, which makes the Top-Down Design a suitable approach. Focusing on the layers most important to the problem, Business and Information Systems, we asked the following questions:

### 1.3 Document Structure

This paper comprehends 4 parts: the Introduction, already covered, where we identified the problems that motivated the development of this paper, and how Enterprise Architecture can be used to solve them. In State of the Art, we describe the relationship between Enterprise Architecture and Digital Transformation. We introduce three cases of Digital Centers, implemented in different Public Administrations: UK, Italy and Singapore and analyze the differences and similarities between them. We also provide an overview of the frameworks and languages associated to the practice of Enterprise Architecture; In the Proposal section, we develop a first draft of TicAPP's architecture, focusing on its governance structure. In the Evaluation section we define how we plan to evaluate ticAPP architecture. We consider its external quality, i.e its fitness for use, which is perceived by the stakeholders and internal quality as the quality of the model itself.

## 2 STATE OF THE ART

### 2.1 Enterprise Architecture

Enterprise Architecture (EA) provides a coherent set of principles, methods and models used in the design and realization of an enterprise's organizational

structure, business processes, Information Systems (IS) and infrastructure (Lankhorst, 2005). An effective EA contributes to a better alignment between the two domains it concerns: Business and IT (Alonso, 2010). This results in more integrated services that feel responsive to the citizen. It helps to define better business requirements that promote an efficient and effective IT infrastructure. It facilitates information sharing and implementation of best practices and guidelines across the organization. Within the business domain, the business architecture manages the design, development, implementation and improvement of the company business, adding value to businesses. The absence of defined standards, running redundant resources to support the business, which can result in inconsistent data, makes it difficult for a company to answer business and economic changes. In the public administration, we also have to account for political drives. Enterprise Architecture, provides the tools and methodologies needed to address the complexity of digital transformation working around new and arising issues systematically (McSweeney, 2016). In the public sector, Enterprise Architecture aims for better resource sharing and enable efficient information exchange across departments. It improves service delivery, enhancing back office processes, adopting shared platforms. Shared platforms are open platforms that improve sharing of resources and coordination across departments when delivering citizens, a service. It must be incrementally extensible, as new partners gradually desire to join. They derive from clear political objectives, which leads to the conclusion that, in order to be successful, it is important for an Enterprise Architecture program to be strongly backed by the Government. Considering a real case of Enterprise Architecture, the UK xGEA was cross-Government Enterprise Architecture. It allowed the integration between existing architectures and future ones across the government. The outcome was a blueprint for the government to have business and IT aligned.

### 2.2 Center of Excellence

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 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 func-

tions 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 (Accenture, 2013). In the following section, we present three examples of Digital Centers of Excellence. They were chosen due to their impact on transforming their governments, by enhancing the operation of the public administration services.

### 2.2.1 UK Government Digital Service (GDS)

The GDS aimed to improve citizens' relationship with the government by delivering better services and helped the government to become more efficient and effective, thus reducing the costs incurred by IT (GOV.UK, 2018a). On the one hand to improve citizen interaction, GDS created a single point of access to the government services to facilitate access to information, the GOV.UK. On the other hand, it was necessary to build digital skills and capability across the Public Administration. The GDS Academy was created to equip the government with more specialized people and ready to handle the problems of the digital future. One driver of this transformation was Digital Identity, which allows people to prove their identity online. Working with several partners across government, they developed the GOV.UK Verify Platform. Verify is used to protect public services against identity fraud and other malicious activity. The GOV.UK Verify turned the UK into reference in digital identity. Other European countries, like Italy, have incorporated similar systems, sharing the same guidelines, standards and best practices of the underlying UK version. The UK also aims to leverage public data, to enable better data-based decision making. They built and expanded data science and analytic capabilities across government, and improved data sharing across organizational boundaries. Government legacy systems made it hard to share information. There was too much duplication, overlap and contradiction in the government. They addressed this issue through the development of a shared Platform as a Service (GOV.UK.PaaS) for government services. The GDS houses approximately 850 people (GOV.UK, 2018a). It is part of the Cabinet Office and it is governed by the Ministerial Group on Government Digital Technology (GOV.UK, 2018b). Their main business activities are simplifying public services, increase collaboration between departments, by creating shared platforms based on open standards and apply Data Science for better decision-making.

### 2.2.2 Italy Team Digitale

The Digital Transformation Team (Team Digitale) was organized to create a new, more effective, Italian Public Administration built on 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 development, Cybersecurity, UX and Data Science. Their strategy was devised in three fronts, each with its role on Digital Transformation of the Government: At a national level, to define the rules, standards and implement enabling platforms, which are solutions that offer fundamental, crosswise and reusable functionality in individual projects (TeamDigitale, 2018). These platforms make the methods of delivery uniform, which enables consistency across the Public Administration. The Central and Local administrations developed services that best suited their needs by following the guidelines previously established. This was accomplished through the use of in-house or external providers, and collaborating with the private sector, to explore new solutions that easily integrate with the national platforms. These actions aimed to reduce the complexity of the services provided to citizens and businesses, by having secure, scalable and reliable architectures, supported by clearly defined APIs. It also supports data driven decision making, by introducing recent data analysis methods such as Big Data and Machine Learning. As part of their strategy, Team Digitale re-launched 3 existing platforms: A central payment platform for all administrations (PagoPA), a digital identity service to facilitate access to digital public services (SPID) and a single national database for Italian Residents (ANPR). Then, they built new ones on top, such as Developers and Designers Italia, two open platforms for public services' front and back-end development. The Data & Analytics Framework, used for sharing and analyzing public data, to avoid information silos between administrations. The API Ecosystem is an API Management system, comprising standards and guidelines to expose and share functionality across the Public Administration through APIs. Operation and technological principles were defined by Team Digitale, with Security and Privacy as the most important principles that cannot be compromised. Every service and policy should be as simple as possible, to facilitate usage by the citizens. It should also prioritize a mobile approach when developing services, and explore existing open source technologies. Existing assets should be enhanced, instead of rebuilding what is already in place. The architectures follow modern design enco-

mpassing reliability, flexibility, security and service-oriented approaches. Rely on data to solve complex problems supported by Machine Learning and Artificial Intelligence and perform analysis to produce useful information and share it publicly, along with other documents illustrating new developments and benefits associated. The team has a long-term vision for the Italian administration’s transformation, with continuous learning and improvement and adding, however it will also identify intermediate milestones to add value to the citizen more quickly. It is a cross-organizational effort where each administration implements its digital transformation such as rationalize data centers, share data with other organisms, adopt cloud solutions, the development of a single digital identity system and include a payment platform in the services delivered, according to will find in the strategy defined and several guidelines. The guidelines are meant to create a fundamental set of architectural and design principles, rules of usability and interoperability as a basis for the operational strategy. The drivers behind these initiatives meant to reduce expenditure of administrations, improve the quality of services offered to citizens and businesses and the tools made available to public administrations. Enterprise Architecture is present in Team Digitale strategy. They have a comprehensive description of the organizational structure, where they identify their IT areas and their main business activities, such as simplify interaction with the Public Administration, enhance user experience, promote an architecture based on interoperability between public services.

**2.2.3 Singapore CentEx for ICT**

The Singapore Strategy commits to deliver intuitive digital services that meet citizens’ needs, complete government transactions in a paperless and presence less way using any device (mobile, computer) at any time (SmartNationSG, 2018). 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. CentEx embraced areas of expertise, like IoT, Data Science Application Design, Development and Deployment. In order to reduce costs and deliver IT projects on time, the Singapore Government aims to streamline platforms where possible and customize where it is needed, meaning that they wish to enhance interoperability between systems and agencies. They implemented the SGTS (Singapore Government Technology Stack), a collection of digital services to build their digital applications and reduce the time required to deploy new solutions. This allowed agencies to focus on meeting citizens needs and deliver a

seamless, consistent and connected experience across all government agencies. It adopted a “Once Only” policy by providing the relevant data and requests one time and sharing them with right public agencies to address the situation. This means citizens must feel confident and assured their data is secured by the government. The MyInfo Initiative part of The National Digital Identity, is a “once only” service, meaning citizens filled their personal details automatically in online forms one time. The Singapore Public Administration had also developed internal services, like WOGGA, a platform to monitor all government digital services and identify gaps in service delivery. Nectar, a PaaS, designed to host all government digital services. The APEX, a data sharing platform that facilitates data-driven decision making and service delivery for government agencies by exchanging data securely through APIs. Enterprise Architecture is present in Singapore’s CentEx, by having a clear organizational structure and main business processes: facilitate data-driven decision across the Public Administration, to build shared platforms, integrate services around citizens and business and run secure and robust systems.

**2.2.4 Comparative Analysis**

The grounds for comparison focus on the objectives these centers drew while they were operating, the projects developed and how they were aligned with the country’s digital strategy. While implemented in governments with different structures they corroborate one another. In order to have clearer view of these cases we summarized the most important information in the following table.

Case	Organization	Domains	Projects	Status
UK GDS	Houses approximately 850 people, Part of the Cabinet Office governed by the Ministerial Group on Government Digital Technology, the Digital and Technology and Data leaders	Data Science	GOV.UK Performance	Beta Stage
		Software Development	GOV.UK Design System	Beta Stage
		Identity Management	GOV.UK Verify	Active
		Payment Platforms	GOV.UK Pay	Beta Stage
Italy Team Digitale	29 experts in software development, software architecture, open source payments, product and content design, user experience, big data and data science	IS Architecture	GOV.UK PaaS	Beta Stage
		Data Science	Data Analytics Framework	Active
		Software Development	Designers/Developers Italia	Active
		Identity Management	SPID	Active
		Payment Platforms	PagoPA	Active
Singapore CentEx	Composed of Data Science and AI, ICT Infrastructure, Application Development, Sensors and IoT, Cybersecurity, and GeoSpatial departments	IS Architecture	API Ecosystem	Active
		Data Science	SGTS projects	Active
		Application Development	SGTS projects	Active
		Identity Management	MyInfo (part of the SGTS)	Active
		Payment Platforms	SGTS projects	Active
		ICT Infrastructure	WOGGA, Nectar, APEX	Active

Figure 1: Summary of the three cases observed (UK, Italy and Singapore).

These digital centers of excellence are all collaborating with the public administration to help them with their transformation. Acting as an in-house reserve of deep technical skills, in areas where internal capabilities are needed, they deal with highly complex issues on short notice. They collaborate to build platforms, standards guidelines and best practices and digital services Singapore, Italy and the UK share capabilities such as Data Science, API oriented



services development, Identity Management and Application Development. However, Singapore is also focusing on Artificial Intelligence, Sensors and IoT, Cybersecurity, and ICT Infrastructure, and Geospatial plans. The three approaches share two common goals: On the one hand support the government in digital transformation by investing on cross organizational communication and support by enforcing standards across public bodies; having reliable, fault tolerant, resilient and secure systems and motivating the use of API's for knowledge sharing across the Public Administration. They organize themselves around the stakeholders instead of the ministries and help build common digital and data platforms thus increasing the use of shared platforms, components and data registers across government reducing redundant and wrong information. 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. On the other hand 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). Italy goes one step further by explicitly stating a mobile-first thinking, meaning government services are designed so citizens can access them at any time at their mobile device. So, we can observe that even with distributed locations (Singapore - Southeast Asia, Italy- Southern Europe and the UK - Northern Europe) and different political settings these centers of digital excellence share similar milestones, such as identity management, once-only policies common platforms and promote data sharing across the public administration, by handling complex projects with tight deadlines. They differ in some of the departments of digital fields they house but have Data Science and Analytics and Application Development. The following figure represents a quadrant summarizing the scope and domain of IT and its application across the Public Administration or in each sector:

ticAPP shares the same motivation as the other centers - to support the digital transformation process of government areas by incorporating internal knowledge and competencies and the development of cross-government projects (Portuguese Council of Ministers, 2018). Based on the comparative analysis Italy's Team Digitale is the closest case. Both are under a prorogation regime, with the possibility of being extended for a given time period, which happened in Italy. They're both southern Europe coun-

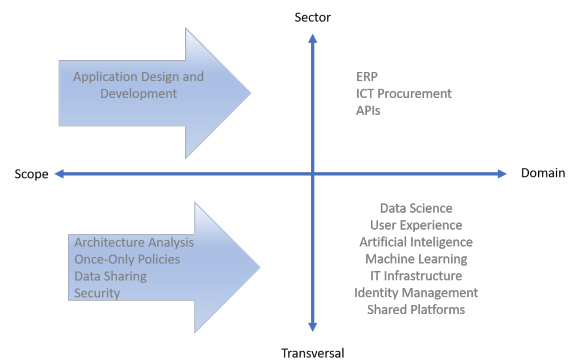


Figure 2: Transversal vs Sector Application of Digital Transformation in the Public Administration.

tries, meaning they share close political systems and views, which influence the operation of these centers. But because the UK GDS inspired Team Digitale, it holds valuable information to be incorporated at ticAPP.

## 2.3 Frameworks and Methodologies

### 2.3.1 TOGAF

The Open Group Architecture Framework is an enterprise architecture framework, aiming to provide high-level design concerning four architecture domains: Business, Data, Application and Technology. In the Business layer, we focus defining the business strategy, governance, organization, and key business processes of the organization. The Architecture Development Method, provides a way of working (a method) for architects (Lankhorst, 2005). It is a cyclic and iterative process to build a holistic architecture of the enterprise. ADM is a comprehensive method, meaning it can be implemented in organizations of any size and structure. It allows for integrating features from other frameworks, like the Zachman's Framework (Schafrik, 2011). Zachman Framework provides a way to categorize them and TOGAF the means to create the artifacts. TOGAF is closely related at the strategic alignment, so it usually follows a Top-Down Design approach.

## 2.4 Modelling Languages

### 2.4.1 Archimate

ArchiMate enables architects to describe, analyze, and visualize the relationships among business domains by using common language for describing the design and flow of business processes, organizational structures, information flows, systems, and infrastructure. It removes ambiguity brought by different stake-

holders. Its hosted by The Open Group and fully aligned with TOGAF. It helps stakeholders to assess the impact of design choices and changes. Archimate approach on architectural models is based on a layered, service-oriented perspective, meaning the top layers consume services delivered by the lower layers. The concepts are similar between layers at an abstract level but become finer grained as we reach deeper layers. Aside from a Motivational Layer, to help describe the enterprise’s goals and drivers, Archimate distinguishes three main layers: Business, Application and Technology. The Business layer offers products and services to external customers, which are realized in the organization by business processes performed by business actors and roles.

### 3 PROPOSAL

Considering the comparative analysis 2 with the summary table 1 and the quadrant previously made 2, we found that these centers of digital excellence share similar objectives and knowledge areas. To answer our problem, we aim to design ticAPP’s Business Architecture. We will be adopting the TOGAF framework and following a Top-Down Design approach. The result will be a reference architecture, that may also be considered when implementing other Centers of Excellence. The solution is based on design science research methodology, DSRM (Hevner et al.), where an innovative solution (an artifact) is developed in line with the problem domain, hence the artifact we chose to develop is a Reference Enterprise Architecture for ticAPP, that can be used in future Digital Centers of Excellence. This architecture encompasses a collection of models, based on the ArchiMate to describe ticAPP in a holistic perspective. Because our focus is on the Business domain, our target architecture is about the people, processes, products and strategy of ticAPP. We chose TOGAF framework to provide guidance on what viewpoints need to be modeled. Based on official government documents, previously mentioned, and other information from Pedro Viana, we were able to collect business statements for ticAPP. This will enable us to create a baseline architecture. The first architecture element to model is ticAPP context. We need to understand who are the stakeholders and how they relate to ticAPP.

Next we modeled an organizational view, depicting an in-depth viewpoint of ticAPP’s internal structure. TicAPP will house 20 IT specialists, with one appointed as coordinator/ director, depicted in the following image as the actor “Director\_X” with the role of “ticAPP Director”. Resorting to additional infor-

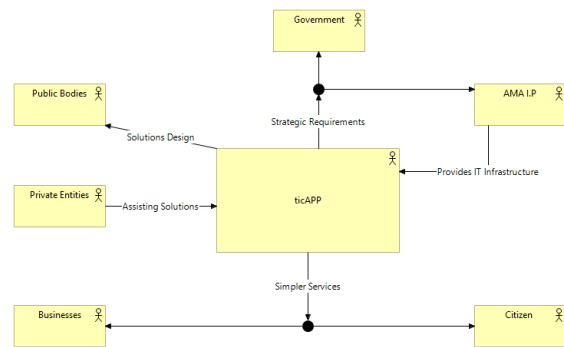


Figure 3: Stakeholders and their relation to ticAPP.

mation, ticAPP should be divided in three departments: Architecture, Transformation and Data Science, each with a team leader directly to the director along with a project manager (Actor- “John Doe” Role - “PMO”).

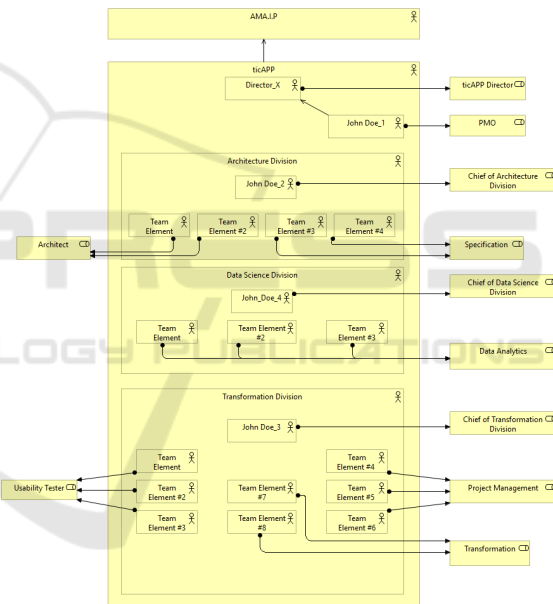


Figure 4: ticAPP’s Organizational Viewpoint Model.

From the previous diploma (Portuguese Council of Ministers, 2018), we also collected information about what activities ticAPP will perform. These are performed by three departments. We identified five services ticAPP delivers: Maintaining Information Systems, Managing Digital Services, Project Management, Assisting the Public Administration with IT Soltution (e.g Acquiring software/hardware) and Supporting Data-Driven Decision through Data Science. To understand what products ticAPP offers, we developed a Product viewpoint. It groups the services delivered by ticAPP by the value they offer to the stakeholders. Each product must have a contract associated. Since Data Science deals with potentially sen-

sitive data, we find it relevant to have contract, committing to GDPR compliance. As for architecture or transformation projects, a Service Level Agreement (SLA) should be drawn.

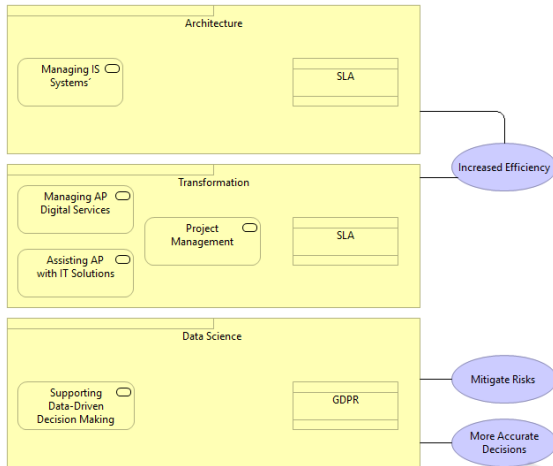


Figure 5: ticAPP's Products.

Next we developed a model, showing how business functions should be distributed across ticAPP. The Architecture Department, specifies Information Systems and manages their Architecture. The Transformation department is responsible for publishing guidelines and reference guides, to be adopted across public administration, to increase coherence among government portals and enhance user experience. It also implements project management initiatives across the Public Administration, supporting their transformation by process modelling and optimization. These means introducing techniques, such as Agile development. They're also in charge of testing and auditing IT solutions across the Public Administration. From these activities we identified 3 services. Lastly, the Data Science Department, in charge of producing predictive models, for fraud detection for example, that realize the service of contributing to better data-driven decision.

TicAPP's mission, i.e its role, is to provide digital services to the Portuguese Public Administration. We considered relevant to link the business functions of ticAPP to the services it delivers. This enables us to observe what every department is in charge of delivering. From the services identified in Figure 5, we developed a model depicting those relations.

#### 4 EVALUATION

We propose a twofold evaluation model. First, we need to assess its external quality, i.e the fitness for

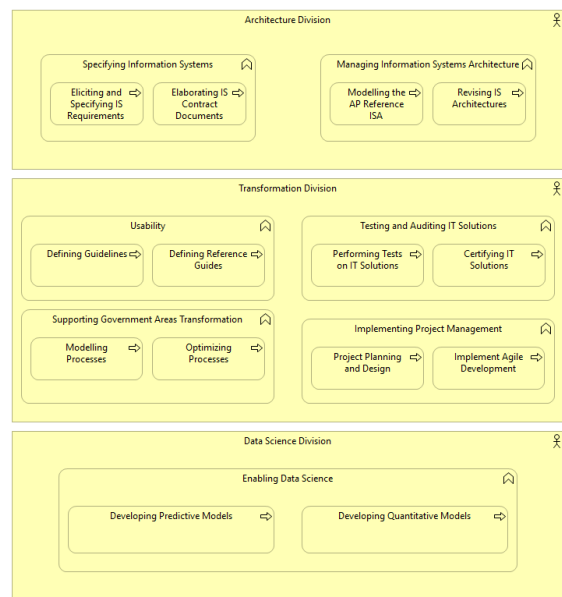


Figure 6: Business Functions distributed by ticAPP's structure.

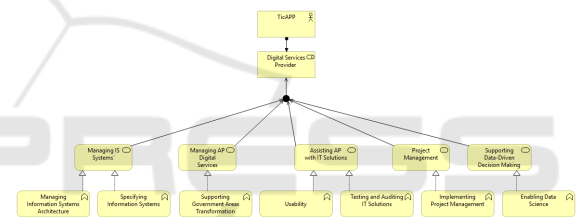


Figure 7: Business Functions link to Business Services.

use of the architecture. These is necessary to understand whether the architecture is a correct and complete representation of ticAPP. The degree to which the external quality is high or low is determined by the stakeholders. Next, we will evaluate ticAPP's maturity using the ACCM (Architecture Capability Maturity Model) framework, which is included in TOGAF. ACCM solves the problem of managing change effectively, by structuring the various practices into levels. Each level represents an increased ability to control and manage the development environment. The goal of ACCM assessments is to enhance enterprise architectures, identifying quantitatively weak areas and to follow an improvement path for specific identified gaps of the assessed architecture (TOGAF, 2018). We

Level	Description
0 (None)	No IT architecture program. No IT architecture to speak of.
1 (Initial)	Informal IT architecture process underway
2 (Under Development)	Enterprise Architecture process is under development.
3 (Defined)	Defined IT architecture including detailed written procedures
4 (Managed)	Managed and measured Enterprise Architecture process.
5 (Measured)	Continuous improvement of Enterprise Architecture process.

Figure 8: ACCM Maturity Levels - (TOGAF, 2018).

will first calculate the maturity rating by obtaining a

weighted mean IT architecture maturity level. Next we will calculate the percentage achieved at each maturity level for the nine architecture characteristics (TOGAF, 2018).

## 5 CONCLUSIONS

We have seen there is a great investment in digital transformation, to steer Public Administrations from its silo-based structure to a more citizen oriented one. Enterprise Architecture aims towards better resource sharing, to enable efficient information exchange across departments and to adopt flexible frameworks. Successful EA programs are generally strongly backed by the highest level of government. We have presented Centers of Excellence in Public Administrations from UK, Italy and Singapore. These had great political backing and made use of shared platforms. These house formerly scattered resources, into single access points. Italy, UK and Singapore, implemented Digital Centers of Excellence specializing in recent fields of IT, such as Data Science and Application Design and Development. They leverage digital technologies, are share many similarities. From the literature reviewed about other Digital Centers of Excellence, they share similar strategic goals and perform the same activities. However, we found no model or reference guide on how to set up one of these centers. So, we designed ticAPP business architecture, as a possible reference architecture for other Centers of Excellence in Public Administrations. Our goal was to develop an artifact, i.e a business architecture model, for a consistent approach on how to implement a Digital Center of Excellence. We followed a Top-Down Design approach, based on TOGAF ADM methodology. We modelled viewpoints, concerning the structure and core processes that support the services ticAPP provides. Our models, cover a great scope and detail of the structure and operation of ticAPP. Feedback from stakeholders, regarding the quality of the models was positive and continuous improvements to the models will be made. This means the models are fit for purpose, in a way that they represent a correct and complete representation of ticAPP.

## ACKNOWLEDGEMENTS

This work was supported by national funds through Fundação para a Ciência e a Tecnologia (FCT) with reference UID/CEC/50021/2019 and by the European Commission program H2020 under the grant agreement 822404 (project QualiChain).

## REFERENCES

- Accenture (2013). Banking on digital: Enabling a digital first mindset. [https://www.accenture.com/aen/~media/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Technology/\\_7/Accenture-Interactive-Banking-Enabler-Digital-Operating-Model.pdf](https://www.accenture.com/aen/~media/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Technology/_7/Accenture-Interactive-Banking-Enabler-Digital-Operating-Model.pdf).
- Alonso, I. A. (2010). Enterprise architecture responsibilities and people roles.
- CTIC (2017). ICT Strategy 2020. [https://www.tic.gov.pt/documents/2018/CTIC\\\_TIC2020\\\_Estrategia\\\_TIC\\\_EN.pdf](https://www.tic.gov.pt/documents/2018/CTIC\_TIC2020\_Estrategia\_TIC\_EN.pdf).
- GOV.UK (2018a). About the government digital service. <https://gds.blog.gov.uk/about/>.
- GOV.UK (2018b). Our governance. <https://www.gov.uk/government/organisations/government-digital-service/about/our-governance>.
- Lankhorst, M. (2005). *Enterprise Architecture at Work: Modelling, Communication and Analysis*. Springer.
- McSweeney, A. (2016). Digital transformation and enterprise architecture. <https://pt.slideshare.net/alanmcsweeney/digital-transformation-and-enterprise-architecture>.
- Portuguese Council of Ministers (2018). Resolução do conselho de ministros n.º 22/2018. *Diário da República n.º 47/2018, Série I de 2018-03-07, (22/2018):1185 – 1186*.
- Schafrik, F. (2011). A practical guide to developing enterprise architecture. <https://www.ibm.com/developerworks/rational/library/enterprise-architecture-maximum-value/index.html>.
- SmartNationSG (2018). [https://www.smartnation.sg/docs/default-source/default-document-library/dgb\\\_booklet\\\_june2018.pdf](https://www.smartnation.sg/docs/default-source/default-document-library/dgb\_booklet\_june2018.pdf).
- TeamDigitale (2018). Report digital transformation team. [https://teamdigitale.governo.it/assets/pdf/Report\\\_DigitalTransformationTeam\\\_09\\\_30\\\_2018.pdf](https://teamdigitale.governo.it/assets/pdf/Report\_DigitalTransformationTeam\_09\_30\_2018.pdf).
- TOGAF (Retrieved December 2018). Architecture maturity models.