Chapter 12
Enterprise Architecture Case Projects

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Abstract This chapter presents three case studies where enterprise architecture (EA) approaches and design principles are applied. The case studies described are based on real-world projects and challenges. However, some data and information may have been changed for academic, scientific, or confidentiality reasons. For each case study the current business, information, application, and technology architectures are described; afterward several challenges are raised. The goal is to apply the EA and EC techniques introduced in the previous chapters to support the discussion and the decision making regarding the challenges presented. The first case study refers to the EA of the Urban Hygiene Unit of the Lisbon City Hall. The second case study addresses Técnico Lisboa faculty EA. Finally, the third EA case study deals with the public procurement process.

12.1 Case 1: Lisbon Smart City Enterprise Architecture[1]

The Municipal Unit of Urban Hygiene of Lisbon hired you to propose an enterprise architecture to transform Lisbon into a smart city. You will start by characterizing the current (AS-IS) enterprise architecture (EA) in order to set a common ground for defining the future path (TO-BE).

12.1.1 Introduction

The Municipal Unit of Urban Hygiene (Direção Municipal de Higiene Urbana, in Portuguese, DMHU) of the Lisbon City Council (CM-Lisboa) identified in its operation a set of opportunities that justify the definition of a strategic information systems plan, which should identify the current situation (scenario AS-IS) and

[1] Developed with the contribution of Professor Alberto Silva, Professor Joao Matos, and Lisbon City Hall (DMHU).

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The Enterprise Engineering Series, https://doi.org/10.1007/978-3-030-96264-7_12

also propose improvements to be implemented in the medium term (TO-BE). The limitations provide an opportunity to review the entire circuit management system, as well as to point out measures at the level of the deposition systems, removal fleet, human resources, and management tools, namely, procedures, databases, and IT support infrastructures.

DMHU has a strong relationship with the areas of Human Resources and Finance of the City Council regarding HR (including the recruitment of prospective employees) and financial processes. The contractors and service suppliers and the Parish Councils assist DMHU in the pursuit of its mission, namely, when reporting events and requesting information from the Municipality. Reporting to the regulatory authority is also supported, and cooperation with external entities is developed.

12.1.2 Strategy

The strategy for the Urban Hygiene Unit is part of the Lisbon City Council strategy defined in [1].

The goals and results of DMHU in 2015 are described in the document [2].

12.1.3 Organization

DMHU is divided into two departments supported by seven structures. The Department of Urban Hygiene is, in turn, realized by four support centers and one division. The Repair and Maintenance Department consists of two divisions and a shared structure (Fig. 12.1).

The services provided by DMHU to the outside are structured around six topics:

- Urban hygiene
- Urban cleaning
- Urban hygiene projects
- Transport
- Environmental awareness
- Management of garages and repair shop

Please see document [3] for further details.

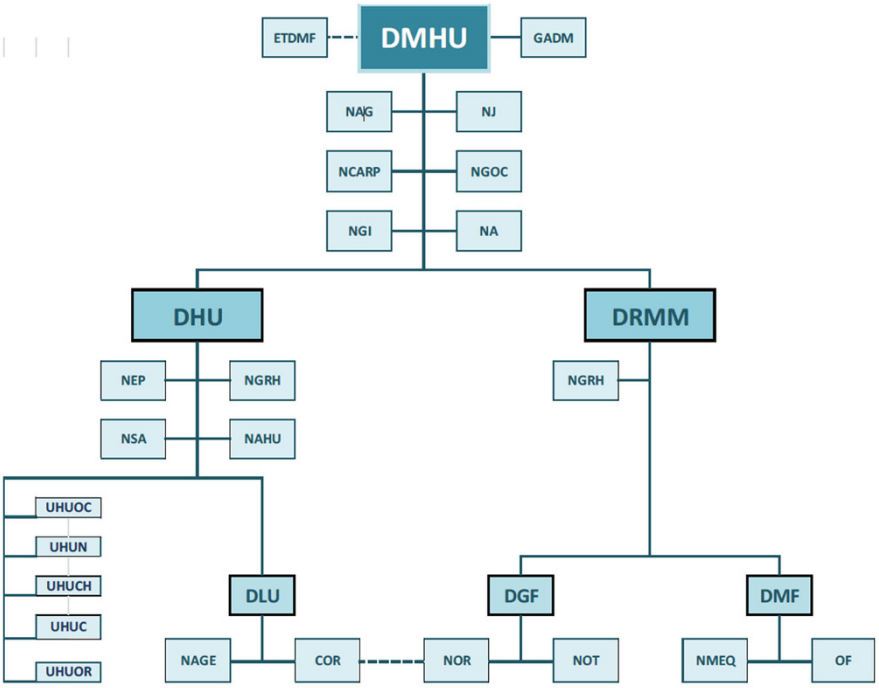

Fig. 12.1 DMHU structure

12.1.4 Business Processes

DMHU's core business is accomplished by five top business processes. Processes with external impact to the Municipality are Waste Collection Management and Relationship Management with the Citizen. HR Management and Warehouse Management are processes internal to DMHU. Fleet Management is another process with interaction with stakeholders external to DMHU (other municipal organic units).

The Waste Management process is structured into four subprocesses: i) planning and management of circuits, ii) management of deposition equipment and container sites, iii) execution of circuit collection, and iv) data registration and conference.

HR Management is developed through six level 1 processes. i) The Registration Management process ensures the creation and management of data of DMHU employees. ii) The HR incident management process includes the absences, attendance, overtime, and consequent payments to employees. iii) The Uniform Management, and Safety and Hygiene at Work process ensures uniform management and safety. iv) The Training Management ensures the definition of training programs and its management. v) The Vacation Management computes the vacations of

each employee and updates the vacation information. Finally, vi) the performance management ensures the assessment of the employees' performance.

The Citizen Relationship Management process consists of three subprocesses. The process of interaction with Occurrence, Order, and Intervention Management (GOPI) ensures the creation of occurrences and requests for intervention at DMHU, as well as the passing of information between the GOPI and the application "Na Minha Rua Lx" ("In my street Lisbon"). The level 1 process that ensures the assessment of the citizen's requests includes the analysis of the request, requests for pests and pigeons, deposition equipment, events, requests for collection, inspection, complaints and suggestions, other types of requests, and also the management, parametrization, and monitoring.

12.1.5 Information

DMHU defines circuits for collecting garbage in Selective Collection Points (PRS). On the other hand, there are work orders, which address assistance requests (which add one or more occurrences of citizens), assigned to employees and inquiry sheets that list equipment (such as machines and vehicles). DMHU employees may also make requests to the warehouse for additional stocks (movable inventory assets).

Occurrences (complaints or suggestions) may have an associated response (and service response, internal to the DMHU), and are created by the citizens. Work orders, which may be the result of requests for assistance, have associated occurrences. Work orders aggregate operations (internal or external) and are assigned to employees.

Regarding Human Resources, the DMHU employee information is composed of his or her attendance information, accidents at work, overtime, incidents, medical aptitude record, and performance evaluation. The employee also attends training actions (integrated into the training course that forms the training plan). Uniforms are also given to the workers (including personal protective equipment). The circuits and work orders are assigned to employees.

Selective Collection Point (SCP, or PRS, in Portuguese) is also an important information, specialized in eight types (selective door-to-door, non-selective door-to-door, container fixing support, underground compactors, surface ecopoint, underground ecoisland, surface ecopoint, and door-to door SCP entity). It has a container location and deposition equipment. The circuits add several Selective Collection Points, freights, support areas, and unloading locations.

Regarding uniform management, the uniforms are given to employees, along with personal protective equipment. The equipment (which is subject to periodic inspection) can also be machines and vehicles (from which movements are recorded). Machines and vehicles can be assigned to garages. The machines are further classified into small and large machines (such as compactor and autocompactor). On the other hand, the warehouse holds stocks (which are movable goods and inventory), which employees can request.

12.1.6 Current Applications

DMHU has used numerous computer applications over the years. Several of these applications have been developed and maintained internally by its support services (referred to as Internal Applications), while others are provided and maintained by third parties or by the central IT Department of the Lisbon City Council.

The main applications that support the DMHU processes are next described.

12.1.6.1 Relationship Management with the Citizen

The following applications are used to support and manage the relationship between the Lisbon City Council and the outside:

- Na Minha Rua Lx (Application_Web, CML-DSI Development). The events portal of the Lisbon City Council (CM-Lisboa), available at https://naminharualx.cm-lisboa.pt/, where a citizen reports problems in public spaces about municipal equipment and urban hygiene that require the intervention of CM-Lisboa or the Parish Councils
- LxRequests (Application_Desktop, Internal Development). Control of requests, complaints, compliments, and requests for information; complaint management in complaint book; interconnection with LU in handling containers by request; interconnection with urban cleaning application (LU) in handling PRS; management of joint surveys; timing and management of specific collections (monsters, greens, debris, and paper); management to support events; management of participation for administrative offenses; record of pest and pigeon control activity

12.1.6.2 Human Resource Management

Support applications for internal HR management at DMHU:

- RH2011 (Human Resources at DMHU) (Application_Desktop, Internal Development). It allows the administrative management of Human Resources with the following functions: employee registration, automation of the creation of evaluation files, postings of daily occurrences (vacations, absences, leave, and work), vacation management; provision of overtime work, elaboration of payment maps, training management, uniform management and EPIS, and social balance.
- RelgioPonto (Application_Desktop, Actuasys Development). Attendance control based on time clock system.
- SST (Workplace Safety System) (Application_Desktop, Internal Development). It includes the entire area of preventive medicine (occupational medicine consultations and issuance of aptitude sheets), professional diseases, accidents, treatments, costs, appointments, calls, etc. Notice that the Medicine at Work

component will be assumed by a new application that is in the acquisition phase; the Workplace Accident Management Component is being migrated to an application developed on Oracle.

12.1.6.3 Urban Cleaning Management

The applications that support the circuit management and urban cleaning management are:

- LU (Urban Clean) (Application_Desktop, Internal Development). Allows Urban Collection Management with the following functions: (i) management of tasks and circuits, (ii) collection point management (PRS), (iii) management of request locations and bag addresses, (iv) producer management, (v) management of container handling, (vi) management of bag delivery, (vii) management of the placement and maintenance of paper bins, (viii) parameterization of vehicles assigned to DHU, (ix) management of mechanical equipment, (x) management of the scales, and (xi) management of freight, weights, transported waste, etc.

  The LU application provides a set of interfaces (using views from the AMOS database), which allow it to be used by third-party applications (maintained by the CM-Lisbon IT), namely, through the Open Data platform of Lisbon. These interfaces provide the following information: collective collection points, community composters, domestic composters, paper receiving centers, ecoislands, underground ecoislands, ecopoints, collection of used food oils, billions, WEEE collection, container fixing support, and glass recycling container.
- Scale (Scale in Operations Management) (Application_Desktop, Internal Development). Application responsible for managing the Service Scales. Its main functionalities are related to the planning of circuits and the allocation of human resources to these circuits. The assignment of employees to their tasks is automatic as long as they are assigned to a circuit and the employee presence is recorded in the biometric system. Subsequently, HTML files are generated that are projected on the televisions of the Operation Center (COR).
- LU_SIG (LU GIS Toolbar) (Application_Desktop, Internal Development). Plugin developed for ArcGIS originally by ESRI, which allows the management of circuits under maps in ArcGIS and interacts directly with circuit management (LU). It was migrated internally from VBA to VB.NET to work on ArcGIS 10.
- Bee2Waste (Dynamic Circuits) (Application_Web, Compta Development). This application is used to plan, optimize, execute, and monitor the usage, maintenance, and other activities of the assets. This application is used to plan dynamic circuits based on the equipment's level of filling.
- Pigeons (Pigeon Management) (Application_Mobile, Internal Development). It allows to register and manage the habits and catches of pigeons.
- Paper Bins (Paper Bins Management) (Application_Mobile, Internal Development). It allows the registration in the field of the movements and maintenance of the paper bins.

12.1.6.4 Fleet Management

Applications that support fleet and vehicle management:

- GIF (Integrated Fleet Management) (Application_Desktop, Quidgest Development). GIF is an asset management application, assets being understood as everything that needs to be managed within an organization including fixed assets, movable assets, vehicles, etc., which is particularly relevant, in this case, for the management of municipal vehicles. This application is used to plan, optimize, execute, and monitor the use, maintenance, and other activities of the managed assets, covering the date of their acquisition, operation, maintenance, and disposal, that is, the entire lifecycle of the asset. It involves the components of asset management (mobile and real estate), fleet management, maintenance management, claims management, and stock and supply management. GIF provides an interface (GIF database link) that allows to consult about vehicle availability, vehicle data that are in the workshop, data related to work orders, and vehicle registration data.
- Municipal Fleet (Application_Desktop, Internal Development). It allows to consult requests made in GIF in a more intelligible and aggregated way.
- Cartrack (Cartrack—GPS System) (Application_Web, Cartrack Development). Vehicle geolocation system. Cartrack provides the Cartrack API interface.

12.1.6.5 Equipment, Uniforms, and Consumables Management

The applications that support equipment management, uniforms, and consumables are:

- Stocks (Stock Management) (Application_Desktop, Internal Development). Management of material requisitions and uniforms. It only contemplates the mechanism for issuing requisitions and delivery notes in order to highlight equipment deliveries. Contrary to what its name suggests, it does not perform stock management. It also allows to control the duration periods of the different uniforms as the forecast of future consumption.
- SAP_SRM (SAP Supplier Relationship Management) (Application_Web, SAP Development). Management of consumable orders to CML Central Warehouse.

12.1.6.6 Other Applications

Other applications that support the actions carried out by the DMHU are:

- Projects (Management of Awareness Actions) (Application_Desktop, Internal Development). Registration of awareness-raising activity, namely, in terms of recording interactions with partners and in accounting for the public present in the actions.

- ProcIndemin (Administrative Processes, Management of Insurance Processes) (Application_Desktop, Internal Development). Monitoring of administrative proceedings (i.e., requests for compensation), namely, in terms of controlling legal deadlines.
- POIs (Points of Interest Management) (Application_Desktop, Internal Development). It allows the creation and characterization of places of interest. It has been used intermittently to register places of interest to keep them under surveillance. It allows assigning coordinates and other characteristics to points; in addition to having a structured register, it allows to create configurable maps.
- GML (External Inspection) (Application_Desktop, Internal Development). It allows the registration of joint inspection actions with the Municipal Police (PM), Hospital Waste, and Photographic Archive of the Inspection Action.
- Vehicle (Vehicle Park Management) (Application_Desktop, Internal Development). Management of the CML car park: When vehicles are collected by the Municipal Police (PM), they are parked in facilities located in Vale do Forno. Through this application, DMHU can track the movements that the vehicle makes in the park and record information relevant to the process of destroying or returning the vehicle.
- SF-PM (PM Inspection Services) (Application_Mobile, Internal Development). Update information on previously loaded requests; collect evidence for transgression; register joint inspection activity with the PM; register inspection actions by hospital producers.
- TNC (Treatment of Non-Conformities (Quality)) (Application_Desktop, Internal Development). Treatment of non-conformities within the scope of the quality management process supporting the monitoring of the result of audits.
- GESCOR (Correspondence Management) (Application_Web, GFI Development). It allows the registration of incoming files, enabling the tracking of processes within the organization. It also allows the production of documents that support the processes.
- SAPFINANCAS (SAP-Finanças) (Application_Desktop, SAP Development). Financial Management Program used by CML.
- GIC (Integrated Management of Offenses) (Application_Web, SYSNOVARE Development). Application of integrated management of offense processes.

Other applications (developed internally at DMHU) used by other entities:

- GestPet (Animal Management) (Application_Desktop, Internal Development). Management of the Lisbon house of animals (entrances and exits of animals). Note: It is exclusively used by the Green Spaces Management Business Unit.

12.1.6.7 Transverse Support Applications

Support applications that are of transversal internal use:

- GestSis (Application Management and DMHU Systems) (Application_Desktop, Internal Development). The DMHU's application and system management system, including the management of apps, users, and access.
- MeiosRec (Means and Resources Management) (Application_Desktop, Internal Development). Management of entities, employees, and contacts (internal and external). A collaborator can only exist in a system associated with an entity.
- Documents (Application_Desktop, Internal Development). Document management—production and monitoring of document circuit at the DMHU.
- CCustos (Cost Center) (Application_Desktop, Internal Development). It allows the management of cost centers.
- SendMessages (Sending messages via Email and SMS) (Application_Server, Internal Development). Application components that support the remaining internal applications for sending email messages (SendMail interface) and SMS (smsdb interface).

12.1.7 Current Infrastructure

12.1.7.1 Technological Infrastructure

The technological infrastructure that supports the applications is made of a set of physical machines (hardware), virtual machines, and other servers (e.g., operating systems, database servers). In general, internal applications, as mentioned above, are desktop applications installed in desktop machines or laptops with Windows operating system. There are also some mobile applications installed in smartphones with Android operating system. The machines/servers are maintained by the central information system department (DSI) of the Lisbon City Council (CM-Lisbon).

12.1.7.2 Support Artifacts

The internal applications consist of (i) desktop applications for Windows, developed on the Microsoft Windows Forms environment and (ii) mobile applications for Android developed on these technologies, and with common access to the AMOS database. In addition, the following frameworks and software libraries are used in the development of desktop applications:

- Framework internal to DMHU (DHURS—Framework.dll, internal). Application library with most of the objects used in the construction of applications; this library simplifies the maintenance of objects used across applications.
- Microsoft App Interop (ADODB.dll, Interop.ADODB.dll, Interop.ADOX.dll; Microsoft). Framework that supports data transfer between applications.
- MapWindows GIS OpenSource (AxInterop.MapWinGIS.dll, Interop.MapWinGIS.dll; https://www.mapwindow.org/). Framework for viewing georeferenced data.
- Microsoft Office Interop (Interop.Excel.dll, Interop.Word.dll, Interop.Office.dll, Interop. Microsoft.Office.Core.dll, Microsoft.Vbe.Interop.dll, Office.dll; Microsoft). Framework that supports the management, reading, and writing of office files.
- Oracle Instant Client (stdole.dll, oci.dll, ocijdbc11.dll, ociw32.dll, Oracle.DataAccess.dll, oran-nzsbb11.dll, oraocci11.dll, oraociei11.dll, orasql11.dll, ojdbc5.jar, ojdbc6.jar; Oracle). Framework installed on desktop clients to access Oracle databases.
- iTextSharp (itextsharp.dll; Opensource https://github.com/itext/itextsharp). Opensource library for interacting with PDF files.
- NetSpell—spell checker for .NET (NetSpell.SpellChecker.dll; Opensource www.codeproject.com). Library with spell checker.

12.1.8 Project Goals

DMHU Director has just hired your enterprise architecture services. He requested that you recommend him the enterprise architecture that DMHU should implement in the next 5 years; in order to do that, you need answers to the following questions:

1. Context
   a. What is the context of DMHU? Who are DMHU stakeholders and what concerns do they have?
   b. Which business units are involved in managing the flows between DMHU and its context?
2. Products and Services
   a. Which products and services are provided by DMHU? To which stakeholders?
3. Big Picture
   a. What is DMHU's big picture?
4. Strategy (Means and Ends)
   a. What are the drivers, goals, principles, and requirements for DMHU?

b. Are there any goals, principles, or requirements that are contradictory among themselves?
c. Are there any goals, principles, or requirements that are misaligned or not considered in the remaining enterprise architecture?
d. What are the gaps among the DMHU drivers and goals of 2015 activity plan and the results achieved?

5. Organization Structure

   a. What is the organization structure (and roles) of DMHU?

6. Business Process

   a. What are the core DMHU processes (Levels 0, 1, 2)?

      i. Inputs/outputs: Information entities
      ii. Roles/actors
      iii. For the Waste Collection Management process (AS-IS), it is requested that you describe and characterize using ArchiMate (present your assumptions for describing this process), including:

         A. The flow
         B. The inputs and outputs
         C. The critical points
         D. The break points

7. Information Entities

   a. What information entities support the business processes?

      i. Major attributes
      ii. (Business) Identifier
      iii. Inmon classification for the attributes

   b. What are the structural relations among the information entities?
   c. In which business processes are the information entities created, updated, read, or deleted?

8. Application Architecture

   a. AS-IS

      i. What are the current applications that support DMHU processes?
      ii. What processes and information does each application support?
      iii. What approach do you recommend to classify each application as keep, discontinue, and don't know? Explain in detail your approach.

   b. TO-BE

      i. Ideally, what applications should be available at DMHU considering its business processes and information management (just considering the AS-IS business processes and information)? Or stated differently,

if DMHU had no applications whatsoever, what applications would you recommend to support the current business and information?

ii. Considering the ideal application landscape computed above, review your answer to 8.a.iii, and propose a roadmap for each application. Typical roadmap guidelines are maintain, discard, replace, consolidate (with another), improve functionalities, or upgrade technology.

iii. Do you recommend the usage of any application patterns?

iv. What application architecture do you recommend? Model the proposed application architecture, including the application functions and services provided or consumed by the business and by other applications.

v. Besides the application structure, present the application usage, the application cooperation, and the application behavior viewpoints.

9. IT Architecture

   a. What are the different technological options for implementing the applications?
   b. Do you recommend any existing software package? Which are available? How do you compare them?
   c. Do you recommend a custom development for all the applications? Or an off-the-shelf software package? Explain your analysis.
   d. What is the processing infrastructure that you recommend? What about storage? And communication?
   e. What is your recommendation for the IT architecture?
   f. What are the dependencies between the IT infrastructure and the applications? Where does each application will run?
   g. How did you implement each guideline or pattern in the EA of DMHU? Do you recommend considering some other guidelines?

10. Roadmap

    a. What project roadmap do you recommend? Which solutions/applications should be implemented first? Where would you start?
    b. Considering existing applications (AS-IS), propose a global roadmap for the change.

The report should answer the questions above using views in ArchiMate, BPMN, UML, matrix, graphs, and supporting text. This will involve choosing the most appropriate viewpoint to support your answers.

12.2 Case 2: Instituto Superior Técnico Enterprise Architecture

You have been hired to propose a new enterprise architecture for Instituto Superior Técnico (IST) faculty.

12.2.1 Introduction

Instituto Superior Técnico aims to contribute to the development of the society, promoting and sharing excellence in higher education in the fields of architecture, engineering, and science and technology. Técnico offers bachelor, master, and PhD programs and lifelong training and develops research, development, and innovation (RD&I) activities, which are essential to provide an education based on the top international standards—see Fig. 12.2.

Técnico is part of Lisbon University, the largest and the most competitive university in Portugal, and is recognized as a prestigious school at national and international level, namely, in the fields of engineering and science and technology. It comprises Portugalś most prestigious laboratories and RD&I centers.

Técnico offers a wide variety of courses to study, both at the undergraduate and graduate levels, and it is actively involved in several international mobility programs. IST has significantly contributed to creating cutting-edge science and technology, which is the main goal of the school.

12.2.2 Location

Técnico operation is located in three campuses: Alameda, Taguspark, and Tecnológico e Nuclear—see Fig. 12.3.

12.2.3 Organization

Técnico is managed through:[2]

- School bodies
- Other bodies
- Academic units
- Cross-cutting platforms
- Research units of IST
- IST associated research units
- Specialized units
- Administrative and technical support services

[2] Técnico organization is described here: https://tecnico.ulisboa.pt/en/about-tecnico/institutional/organisation/.

Fig. 12.2 Técnico facts and figures (source: https://tecnico.ulisboa.pt/)

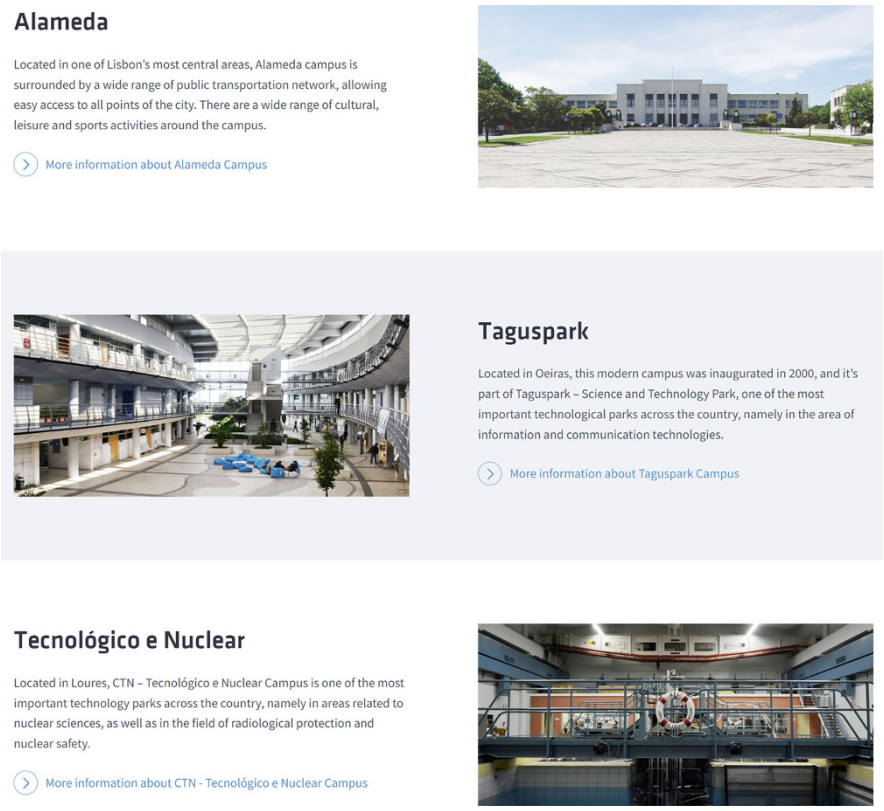

Fig. 12.3 Técnico campuses (source: https://tecnico.ulisboa.pt/)

12.2.4 Strategy

The strategic plan of IST[3] is materialized in a series of initiatives at the management and the operational levels, which have been grouped together into 11 focus areas; see Fig. 12.4.

The focus areas of the EA cover the three components of the core missions of IST (higher education, research, development & innovation and technology transfer) but also include the support and the cross-cutting areas. The three cross-cutting focus areas are shared by all the core activities of IST, closely associated with the needs of a global organization (internationalization and communication) and the need to consider a new aspect of the school organization, its multipolar operation across three distinct campuses. The core activities of IST depend mainly on its Human

[3] In terms of strategy, Técnico strategy is described here: https://tecnico.ulisboa.pt/files/2015/07/plano-estrategico-2015.pdf.

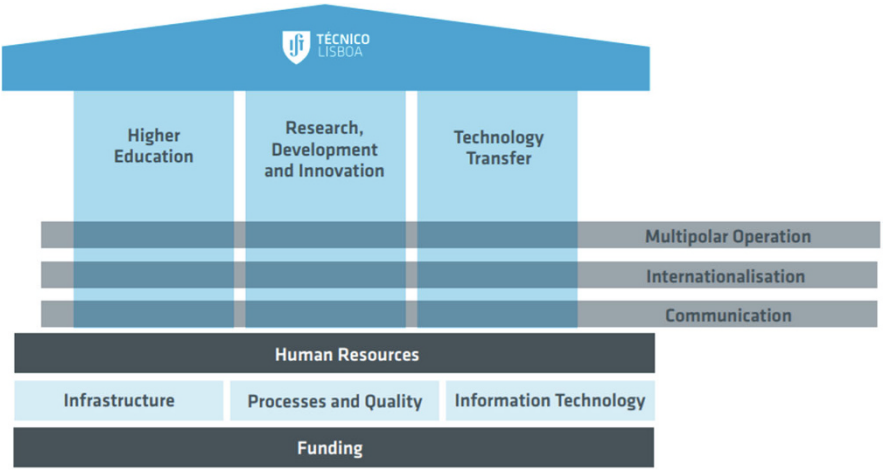

Fig. 12.4 Técnico strategic focus areas (source: https://tecnico.ulisboa.pt/files/2015/07/plano-estrategico-2015.pdf)

Resources, which themselves depend on the support of a number of different areas whose development is addressed in this plan: infrastructure, processes and quality, and information technology. Finally, all the development strategy rests on adequate and flexible funding resources, which have to be further developed in order to make IST as independent as possible from the fluctuations that are inherent to public funding. Please also consider Técnico activity plan described in https://aepq.tecnico.ulisboa.pt/files/sites/22/plano-de-atividades-ist-2017.pdf and the results achieved described in https://aepq.tecnico.ulisboa.pt/files/sites/22/ra-ist-2017_vfinal.pdf.

12.2.5 Business Process and Information

For the purpose of this case study, assume that Técnico business processes are described by the Charles Sturt University (CSU) models.[4] For further detail on the process architecture, please consider that Técnico follows the APQC Process Classification Framework for Education.[5]

Regardless of the above models, assume that Técnico information architecture is based on the following concepts:

[4] http://www.csu.edu.au/__data/assets/pdf_file/0003/51924/process-model-wpp.pdf.

[5] https://www.apqc.org/knowledge-base/documents/apqc-process-classification-framework-pcf-education-excel-version-721.

- Students, teachers, nonteaching staff, Erasmus students, enrollment, enrollment fees, diplomas
- Departments, BA, MA, PhD, curriculum programs, courses, classes, schedules
- Academic exams, course exams
- Accounting, property, wages, real contracts, service contracts, shopping
- Campus, buildings, rooms, equipment, laboratories
- Control point, training, vacations, career and faults of staff and teachers
- Research projects, research institutes, non-faculty researchers, scientific publications
- Library, books, book loans, canteen
- Travel, sabbatical
- Faculty reviews, disciplines reviews, and staff reviews

In addition to these entities, you should also consider those that are implicit (as required) to implement the adopted models of CSU.

12.2.6 EA Guidelines

Consider that Técnico has defined the following principles and guidelines:

- Components are centralized.
- Front-office processes are separated from back-office processes.
- Data is provided by the source.
- Data is captured once.
- IT systems communicate through services.
- Business units are autonomous.
- Management layers are minimized.
- IT systems adhere to open standards.
- IT systems are preferably open source.
- All messages are exchanged through the enterprise service bus.
- Software components are multi-platform.

12.2.7 Project Goals

Técnico's President has just hired your enterprise architecture services. He requested that you recommend him the enterprise architecture that Técnico should implement in the next 5 years' in order to do that, you need answers to the following questions:

1. Context
    a. What is the context of Técnico? Who are Técnico stakeholders and what concerns do they have?

   b. Which business units are involved in managing the flows between Técnico and its context?

2. Products and Services

   a. Which products and services are provided by Técnico? To which stakeholders?

3. Big Picture

   a. What is Técnico's big picture?

4. Strategy (Means and Ends)

   a. What are the drivers, goals, principles, and requirements for Técnico?
   b. Are there any goals, principles, or requirements that are contradictory among themselves?
   c. Are there any goals, principles, or requirements that are misaligned or not considered in the remaining enterprise architecture?
   d. What are the gaps among the Técnico drivers and goals of 2017 activity plan and the results achieved?

5. Business Process
   What are the core Técnico processes?

   a. Inputs/outputs: Information entities
   b. Roles/actors

6. Organization Structure

   a. What is the organization structure (and roles) of Técnico?

7. Information Entities

   a. What information entities support the business processes?

      i. Major attributes
      ii. (Business) Identifier
      iii. Inmon classification for the attributes

   b. What are the structural relations among the information entities?
   c. In which business processes are the information entities created, updated, read, or deleted?

8. Application Architecture.
   You are requested to propose the application architecture to Técnico, including:

   a. What applications should be available at Técnico considering its business processes and information management?
   b. Do you recommend the usage of any application patterns?

c. What application architecture do you recommend? Model the proposed application architecture, including the application functions and services provided or consumed by the business and by other applications.
d. Besides the application structure, please also present the application usage, the application cooperation, and the application behavior viewpoints.

9. IT Architecture

a. What are the different technological options for implementing the applications?
b. Do you recommend any existing software package? Which are available? How do you compare them?
c. Do you recommend a custom development for all the applications? Or an off-the-shelf software package? Explain your analysis.
d. What is the processing infrastructure that you recommend? What about storage? And communications?
e. What is your recommendation for the IT architecture?
f. What are the dependencies between the IT infrastructure and the applications? Where does each application will run?
g. How did you implement each guideline or pattern in the EA of Técnico? Do you recommend considering some other guidelines?

10. Roadmap

a. What project roadmap do you recommend? Which solutions/applications should be implemented first? Where would you start?

The report should answer the questions above using views in ArchiMate, BPMN, UML, matrix, graphs, and supporting text. This will involve choosing the most appropriate viewpoint to support your answers.

12.3 Case 3: Public Procurement Enterprise Architecture

12.3.1 Introduction

Procurement is a central process for any public or private organization. Procurement for government (or public administration) organizations has very well-defined rules and processes which must be applicable, when a public agency buys goods or services such as cars, builds a bridge or a road, buys consulting services, and acquires hardware or software or any product or service that is provided by the market. Government procurement processes look for robustness and transparency while permitting innovative solutions that reflect the scale, scope, and risk of the desired outcome. In the beginning of this millennium, Portugal was a pioneer country moving to an electronic procurement process within public administration. This case study is focused on modeling the current (AS-IS) Portuguese Public

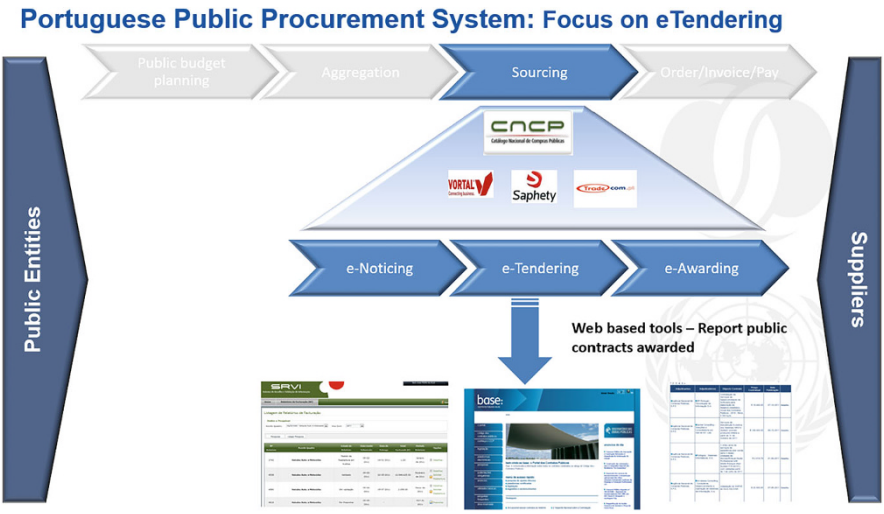

Fig. 12.5 Public Procurement in Portugal overview

Procurement Enterprise Architecture and assessing the impact of different scenarios for evolution.

12.3.1.1 AS-IS

At a high level the Public Procurement in Portugal is described according to Fig. 12.5.

12.3.1.2 Motivation

The major motivations for public procurement are:

1. Value for money
2. Encouraging competition
3. Efficient, effective, and ethical procurement
4. Accountability and transparency in procurement
5. Reducing the risk

12.3.1.3 Business Components

For the purpose of this case study, consider that the business processes that support procurement are described in [4].

Some of the stakeholders involved in the Portuguese Public Procurement process are:

1. IMPIC—http://www.impic.pt/
2. eSPap—https://www.espap.gov.pt/
3. AMA—https://www.ama.gov.pt/web/english
4. GNS—https://www.gns.gov.pt/
5. Tribunal de Contas—https://www.tcontas.pt/
6. INCM—https://www.incm.pt/
7. Public platforms (see updated list at http://www.base.gov.pt/Base/pt/PlataformasEletronicas/EntidadesCertificadas)
8. European Commission
9. Public administration agencies and departments (buyers)
10. Suppliers

The role of each organization within the public procurement process is described, for example, at Law 96/2015, Art. 34 (see https://www.anacom.pt/render.jsp?contentId=1379112.)

12.3.1.4 Information Architecture

Some of the information assets used in the procurement process are:

1. Tender
2. Organization
3. Identifier
4. Address
5. Contact point
6. Item
7. Classification
8. Unit
9. Document
10. Lot
11. Bid
12. Parameter
13. Lot value
14. Award
15. Question
16. Complaint
17. Contract
18. Period
19. Date
20. Value
21. Revision
22. Cancellation
23. Feature

Notice that you may identify other information entities and attributes.[6]

12.3.1.5 Information System Components

Currently public procurement process is supported (from the perspective of any Portuguese public agency) in three major system components:

1. All the financial aspects of the acquisition process are supported by GERFIP, a SAP Finance Module implementation for the Portuguese public administration (see https://www.espap.pt/spfin/Paginas/spfin.aspx).
   The following SAP modules are implemented in GERFIP:

   a. AA: Asset accounting
   b. MM: Material management expenditure process
   c. SD: Sales and distribution sales process
   d. FI-TR: Treasury solutions and POCP accounting
   e. CO: Analytics accounting
   f. EAPS: Budget accounting

   GERFIP is provided to public organizations in a software-as-a-service approach by another public agency: eSPap.
2. The approach to the market, and the evaluation, submissions, and tender conclusion and contract signature processes are supported by public procurement platforms.
3. All the remaining activities within the procurement process are done without a support of a specific system, including the planning of the procurement, the procurement scope, the determination of the procurement method, and the preparation of the market approach. Most organizations support these activities using email systems and paper-based workflows.

12.3.1.6 Technological Components

From a technological perspective assume the following:

1. GERFIP is a central system shared by all public agencies supported in the following technological platforms:

   a. Presentation layer. The presentation layer is provided through Java Server Pages (JSP) and Business Server Pages (BSP).
   b. Business layer. The business layer consists of a J2EE 5 run-time environment that processes the requests passed from the Internet Communication Manager

[6] Please see open procurement project for further details: http://api-docs.openprocurement.org/en/latest/standard/index.html.

(ICM) and dynamically generates the responses. The business logic is written in Java (J2EE).

c. Integration layer. The local integration engine is an integral part of SAP Web AS and allows instant connection to SAP. The local integration engine provides messaging services that exchange messages between the components that are connected in SAP.
d. Connectivity layer. The Internet Communication Manager (ICM) dispatches user interface requests to the presentation layer and provides a single framework for connectivity using various communication protocols (e.g., HTTP, HTTPS, SMTP, SOAP, CGI).
e. Persistence layer. The persistence layer is supported in an Oracle 11g Enterprise Edition implemented on a Linux Red Hat Enterprise operating system in a cluster with four physical servers.
f. The connectivity, integration, business, and presentation layers are implemented in virtual machines (two VMs for each layer) that are supported in a six-blade server and a shared EMC storage (also used for the persistence layer).

2. From an infrastructure point of view, assume that the public procurement platform is supported on a Microsoft Windows server 2012 infrastructure with:

a. Database: Microsoft SQL Server 2012.
b. Active directory.
c. Microsoft SharePoint 2013 that supports the business logic.
d. IIS web server.
e. Search and document indexing is done through Microsoft FAST engine.
f. All components are redundant and there are three different security network zones for the database, web, and business logic.
g. All servers are virtual and are supported on a farm of four physical servers and an HP storage.

3. The email server used by most public agencies is a Microsoft Exchange 2019, and the client uses laptops with Windows, Outlook 2019, and Firefox browsers.

12.3.2 Public Procurement Interoperability Initiative (TO-BE)

In order to move the Portuguese Public Procurement to the "next level," an interoperability initiative is being implemented (see Portuguese law 96/2015). Currently, each buyer has access to a single public procurement platform, and only the suppliers enrolled in that specific platform are able to receive information or present proposals. Therefore, suppliers are required to be enrolled in several (or even all) procurement platforms (e.g., acinGov, anoGov, comprasPT, gatewit, saphetyGov, and vortalGov) to be able to present proposals to different public agencies. The major goal of the public procurement interoperability initiative is to

allow each supplier (and buyer) to use a single platform and be able to interact with buyers enrolled in other platforms. The business services that platforms are expected to provide among each other are:

1. Pronounce in preliminary hearing
2. Access to procedures and published requests for proposals
3. Complaints and disputes
4. Participation in electronic auction
5. Award decision
6. Messaging
7. Qualification document delivery
8. Submission of proposals
9. Complaints on the draft contract
10. Requests for clarification and lists of errors and omissions
11. View posts and warnings created by contracting authorities

Besides these services that each platform must provide, the IMPIC and other public procurement governance entities request to have monitor and control functionalities on all acquisition procedures (gathering information from procurement platforms). Additionally AMA provides an integration platform (iAP; see http://www.iap.gov.pt/) that is being considered (among other options) to be part of the solution architecture. The Portuguese Government needs your help in selecting the right approach and solution architecture to support public procurement according to law 96/2015, in order to achieve interoperability among public procurement platforms, including an orchestration versus a coordination approach.

12.3.3 The Project to Be Done

Your mission is to propose a plan for the government to achieve the goals of their interoperability initiative for public procurement and to dematerialize and optimize the public procurement process. Your deliverables will be used to guide the interoperability initiative architecture decisions and as a reference architecture for public procurement within the public administration. Namely, your team is expected to contribute for:

1. Modeling of the AS-IS enterprise architecture from a business and system perspective
2. Identification of misalignments at the AS-IS, among IT, information systems, business processes, and strategy
3. Designing and modeling the TO-BE enterprise architecture considering the interoperability initiative and the support of procurement activities within a public agency, including the impacts in the strategy, business process, information, information systems, applications, and technology (analyzing different information system scenarios and proposing one)

4. Proposing an implementation plan that ensures the elimination of the AS-IS gaps and supports the interoperability initiative implementation

References

1. C.M. de Lisboa, Grandes opções do plano para a cidade de Lisboa (2018). Available online at https://www.am-lisboa.pt/documentos/1545323718T4cDF1de1Ud05OZ5.pdf
2. C.M. de Lisboa, Direção municipal de higiene urbana – relatório de atividades 2015 (in Portuguese) (2016). Available at https://sites.google.com/view/eacbook/
3. C.M. de Lisboa, Estrutura organizacional da direção municipal de higiene urbana- reorganização dos serviços e novo organograma (in Portuguese) (2019). Available at https://sites.google.com/view/eacbook/
4. Austrian Government, Procurement Process Considerations (2016)