

Enterprise Architecture Modelling for PBO: A Case Study

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Abstract

The project management (PM) practices that characterize Project-Based Organizations (PBOs) are part of their core business processes. Moreover, some PBOs obtain their incomings by developing and delivering projects, such as construction companies. PBO's design and analysis have been developed from an organizational design perspective applying several frameworks such as Galbraiths' Star Model or McKinseys' 7S. For the same purpose, the systems thinking approach is also a suitable alternative for managing organizational complexity and computer-assisted business design and analysis. Within this perspective, the Enterprise Architecture (EA) managing tool has been widely applied in the information systems industry and, over time, has extended to other industries. EA is a group of principles, methods and models for designing and analyzing the enterprises' organizational structure, business processes, information systems and infrastructure. The use of EA as a management tool has the advantage of graphically showing the interrelationships between different components of an organization. Systems thinking has positioned itself as a suitable perspective for organizing PM knowledge, as shown in the last version of PMBOK (seventh). Following this trend, this research develops an EA model of a PBO and shows how the EA components can represent the specific PM artefacts displayed in a PBO. The obtained model and its completeness is evaluated using the Star Model framework. This work is expected to encourage analysts and project managers to opt for EA as a management and governance tool for their projects and the organizations that host them.

Keywords

Project-Based Organizations (PBO), Enterprise Architecture, Project Management, Organizational design, Organizational modelling

1. Introduction

Project-based organizations (PBOs) partially or completely sustain their value through projects (Atencio et al. 2022 a). Some PBOs base their structure, processes, and strategies on the delivery of projects (Miterev et al. 2017 a; b). This type of organization has captured the attention of scholars due to the growing demand for flexibility and innovation in the business world (Gemünden et al. 2018; Turner 2018). The importance of project development in every organization cannot be overstated. Projects are the means by which organizations deliver value to their stakeholders and achieve their objectives (Fernandes et al. 2019). They are a key driver of change organizations adapting to the rapidly changing business environment (Edition 2021).

In order to effectively deliver projects, PBOs have adopted project management methodologies and tools that ensure the consistent and efficient delivery of project outcomes (Atencio et al. 2022 a). These methodologies, such as Agile, Scrum, and Waterfall, provide a structured approach to project delivery that helps to minimize risk, improve collaboration and communication, and increase the chances of success (Atencio et al. 2022 a).

A project-based organization (PBO) can be represented through enterprise architecture (EA) by mapping its structure, processes, and systems to the overall architecture of the organization (Atencio et al. 2022 a). EA provides a high-level view of the organization and its components, including projects, and helps to align the delivery of projects with the overall strategy and goals of the organization (Lankhorst 2009; Gonzalez-Lopez et al. 2019). Using EA, a PBO can ensure that projects are aligned with the organization's technology and data architecture, business processes, and governance structures (Atencio et al. 2022 a). Moreover, EA helps to ensure that projects are executed efficiently and effectively and deliver outcomes that support the organization's mission and objectives (Foorthuis 2014; Shanks et al. 2018). The EA representation of a PBO also could enable better communication and collaboration between projects, departments, and stakeholders, as it provides a shared understanding of the organization's structure and operations (Atencio et al. 2022 a).

This paper seeks to show how PM components of a PBO can be represented using the EA language to obtain a systems view of a PBO and facilitate its analysis. For this purpose, a case study of EA implementation was developed based on a company in the Architecture, Engineering and Construction (AEC) industry named under the pseudonym BUILD-CON. Its correspondence with the Star Model PBO design framework is analyzed to evaluate the completeness of the obtained EA model regarding the PBO design. Moreover, the evaluation of the modelled EA as a complementary tool for PBO design is developed.

The rest of the article is structured as follows: section two contains the theoretical background of this research, providing a general view of EA, the approaches for PBO design and modelling and how the systems analysis approach can be applied to analyzing business models. The development method for addressing the research objectives is described in section three. In section four, the results regarding the case study are displayed, finishing with the conclusion of this research is in the fifth section.

2. Background

2.1 Enterprise Architecture

Enterprise architecture refers to the structure and organization of a business or an enterprise and the methodologies and frameworks used to design, plan, and implement it (Lankhorst 2009). Enterprise architecture aims to align technology, business, and data strategies to achieve common goals and objectives. It is a holistic approach that encompasses the entire organization and its interactions with external entities (Gellweiler 2020).

Zachman proposed the first EA framework in the eighties (Zachman 1999), which provides a matrix for organizing and categorizing the various elements of an enterprise architecture. It defines four perspectives - who, what, where, and when - and provides a systematic way to define and categorize the various components of an enterprise. Another popular framework is The Open Group Architecture Framework (TOGAF) (Tao et al. 2017), which provides a comprehensive and rigorous approach to enterprise architecture development. TOGAF establishes an Architecture Development Method (ADM) that considers the cyclical development of different phases that move in architecture domains. This framework is widely used in different sectors such as government, telecommunications, manufacturing, defence and finance (The Open Group 2018).

EA Languages play a significant role in enterprise architecture, providing a common language and vocabulary for stakeholder communication and collaboration (Isomaki et al. 2008). In this line, ArchiMate is a widely used language for describing enterprise architecture. It provides a standardized vocabulary and symbols for visualizing the components and relationships within an enterprise architecture (The Open Group 2021).

The frameworks and languages used in enterprise architecture provide a systematic and structured approach to designing, planning, and implementing an enterprise. They facilitate communication and collaboration between different stakeholders (Lankhorst 2009).

2.2 Project-based organization design and modelling

PBO has been a widely studied topic for more than 30 years; however, this type of organization's holistic design has been recently addressed (Miterev et al. 2017 b). One of the recent works in PBO design proposes adapting the Star Model framework proposed by Galbraith (Galbraith 2007). This holistic model addresses five interrelated components critical to achieving organizational success. The first component is strategy, which sets the organization's direction, mission, and vision. The second component, structure, determine the location of formal power and authority and outlines the communication channels within the organization. The third component, Processes, describes the "lateral connections" that facilitate the breakdown of silos within the organization, where information moves through a series of connected activities. The fourth component, Rewards (or Behaviour component according to (Miterev et al. 2017 a)), emphasizes the alignment of individual behaviours and performance through metrics and a reward system. Finally, the fifth component, People (Galbraith 2007), encompasses policies for selecting, staffing, training, and developing individuals who perform activities aimed at achieving the organization's strategy. A comprehensive overview of the concerns addressed in each component is provided in Figure 1.

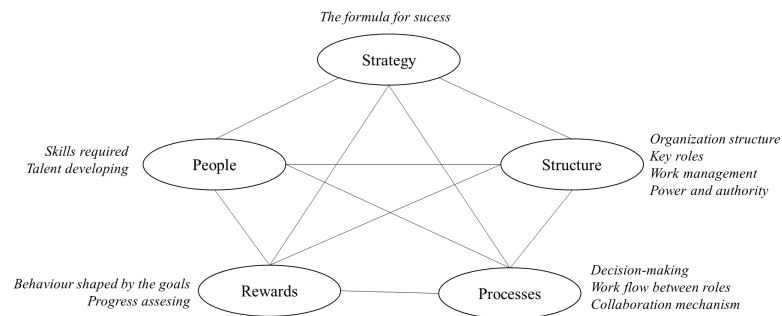


Figure 1. Star Model's organizational design concerns, adapted from (Galbraith 2007)

This framework has been highlighted due to this completeness (Miterev et al. 2017 a; Atencio et al. 2022 b) and the interrelation of these components, providing a more integrated design of an organization. This integration is needed considering that (PBOs) are challenged to handle unpredictable, fluctuating, and erratic environments. PBOs inherently balance the competing demands of differentiation, which arises from the execution of numerous temporary, short-term, and distinct projects, and integration, which arises from the requirement for long-term growth, coordination within the organization, consistency, and dependability over time (Melkonian et al. 2011).

For models analysis (EA and Star Model together, for instance), the systems analysis is an alternative approach for understanding these model from a integrated viewpoint.

2.3. Systems analysis for business models

Systems analysis is a systematic and structured approach to studying a complex system or process to understand how it operates, how it can be improved, and how it can be best integrated with other systems (Bond 1999). This approach involves breaking down the system into components and examining how they interact to accomplish a specific purpose (Bond 1999).

Systems analysis is developed in various fields, including engineering, computer science, business, and the social sciences. System analysis aims to identify problems and inefficiencies and develop solutions that improve the system's overall performance and effectiveness. The above is often done by gathering and analyzing data, creating models, and simulating scenarios to evaluate the impact of potential solutions. EA models are recognized as useful tools for these purposes (Närman et al. 2008).

3. Development method

To address the research objective of this article, a development method has been proposed and described in Figure 1.

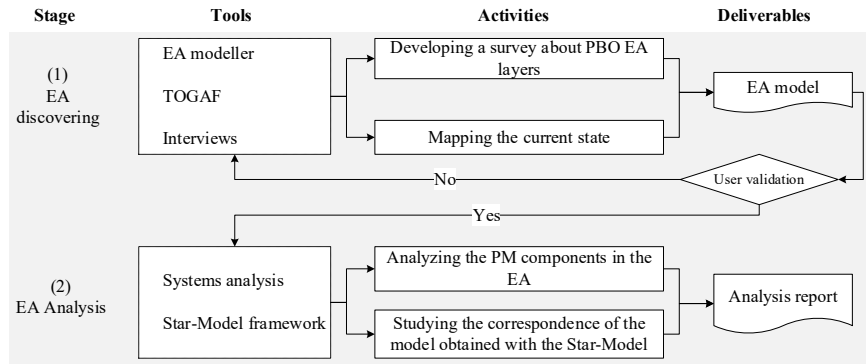


Figure 2. Development method.

Following Figure 1, the first stage considers the activities for describing the PBOs' and their representation in an EA model. The first three phases of TOGAF framework guidelines for EA implementation are developed for obtaining the BUILD-CON models. These models are developed through interviews with different collaborators of the PBO. The BUILD-CON case and its models were implemented using the Archi© software based on the ArchiMate EA language aligned with TOGAF.

TOGAF establishes an Architecture Development Method (ADM) that considers the cyclic development of different phases that move in architecture domains, as summarized in Figure 3. A set of models is needed to perform an architecture description, which can be specified in an architecture description language (Gonzalez-Lopez et al. 2019). ArchiMate language considers three layers of architecture deployed around a static or structural aspect, the behavioural or dynamic and finally, a passive aspect where the objects where the behaviour is performed ("information" column) are located (Lankhorst 2009). The correspondence between TOGAF and ArchiMate is diagrammed in Figure 3. The general manager of BUILD-CON has validated all models to continue to the next stage. The second stage encompasses the system analysis of the PM components displayed in the EA model to evaluate the possibilities of representing the PBO components through the use of EA. The correspondence with Star Model is studied in each model.

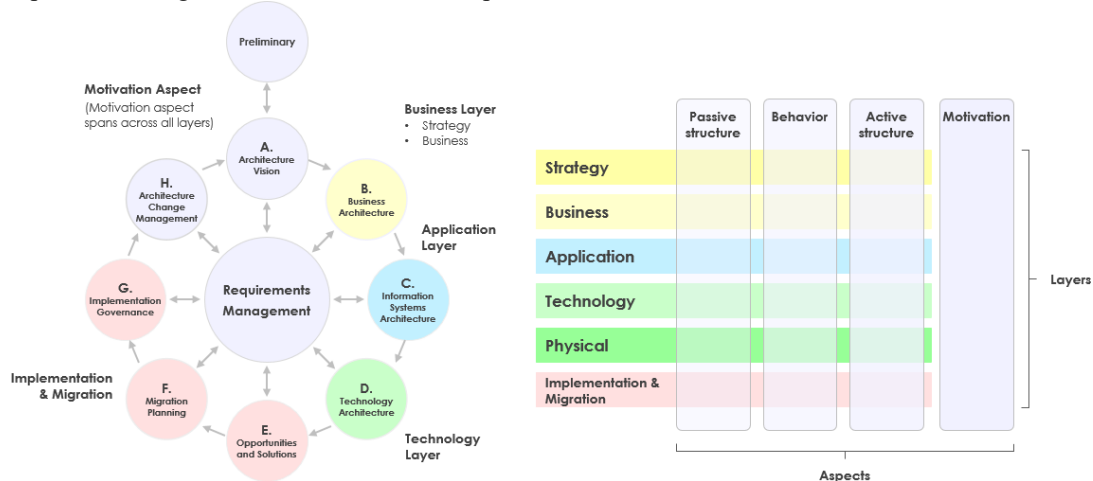


Figure 3. Correspondence between TOGAF and ArchiMate structure (ArchiMatetool 2023; Jonkers et al. 2012).

4. Results and Discussion

The following section shows the development of the method described in Figure 2 and Figure 3 for the EA modelling.

4.1 Phase A

The purpose of this phase is to develop the EA vision. In other words, it corresponds to a strategic analysis of the organization about the usability of the EA, how it will be implemented and its scope. BUILD-CON established that it would use the EA approach for its business governance. As an output of this phase, a general roadmap for EA implementation in the company for the short and mid-term was defined. This roadmap includes a backlog of

operational improvement initiatives and standardization of PM practices to be coupled with EA in the final phases of the TOGAF cycle. This article responds to one of the roadmaps' initiatives.

4.2 Phase B

Phase B of TOGAF considers the definition of an EA's strategy and business layers, as shown in Figure 3. Two models were developed for describing the Strategy layer of an EA: the stakeholders' view and the business goals associated with the driver profit.

Figure 4 shows the stakeholders' view of BUILD-CON. This model is composed of the description of the main stakeholders of the company, in this case, the board, banks and customers and the business drivers (an external or internal condition that motivates an organization to define its goals and implement the necessary changes to achieve them (The Open Group 2021)). Business actors were included to show the direct relationship between these collaborators and the stakeholders.

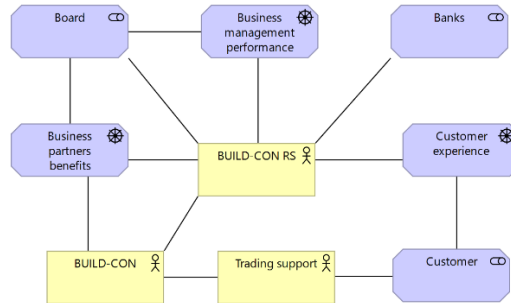


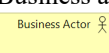


Figure 4. Stakeholders view.

The Stakeholders' view (Figure 4) allows the representation of stakeholders, their concerns, and their assessments. This model is also analyzed in Table 1, to identify the PM components and their correspondence with the Star Model PBO design framework.

Table 1. EA Stakeholders view analysis

EA model: Stakeholders view		
EA component	PM component (PMBOK 7th)	Star-Model component
Stakeholder 	Stakeholders (and the whole stakeholder performance domain)	Strategy
Driver 	Project goals and objectives to the customer organization's goals, objectives, and vision.	Strategy; Rewards
Business actor 	Project team, organizational structure components	Structure; Processes; Rewards; People

As shown in Table 1, the EA concepts (and using the EA taxonomy) maintain the same terminology as PMBOK7. Then, here the representativity of the PM concept through EA elements is direct. Regarding the Star Model (SM) correspondence, the modelled elements relate to the five SM components: strategy, rewards, structure, people and processes.

The drivers' priorities, such as profit, often drive specific business goals. In the case of BUILD-CON, profit is obtained mainly from the project development. Then, the elements of the iron triangle of the PM (time, cost, quality and scope (PMI 2017)) are adopted to improve the customer experience, benefits and business performance. These constraints and their interrelationship are modelled in a business goals/driver diagram, as shown in Figure 5.

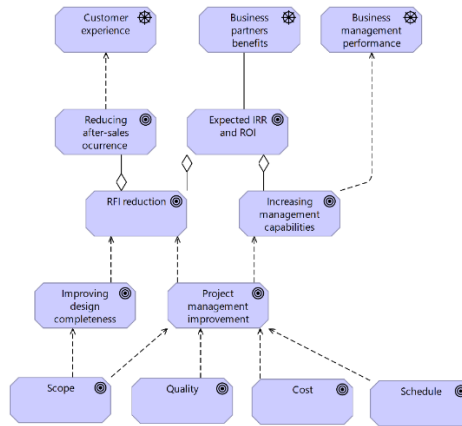




Figure 5. Business goals associated with the driver's profit

In the same way, as for the previous model, the PM components have been represented through EA (Figure 6). Moreover, two SM components are addressed: strategy and rewards, as shown in Table 2.

Table 2. EA business goals and driver profit analysis

EA model: Business goals and drivers view		
EA component	PM component (PMBOK 7th)	Star-Model component
Drivers and goals  	Project goals and objectives to the customer organization's goals, objectives, and vision. The iron triangle is described as a goal in this view (scope, quality, cost and schedule).	Strategy; Rewards

In line with TOGAF Phase B, the business layer of EA is modelled in this step. Different views could be used to represent this layer. For the BUILD-CON case, three types of EA views were modelled: the (i) organizational view, (ii) business function view and the (iii) business process view. The (i) organization view encompasses the internal structure of a company, department, network of companies, or other organizational entities. Models can be presented using nested block diagrams or traditional organizational charts. This viewpoint is valuable for identifying an organization's competencies, authority, and responsibilities (Jonkers et al. 2012; The Open Group 2021). The BUILD-CON organizational structure model is shown in Figure 6.

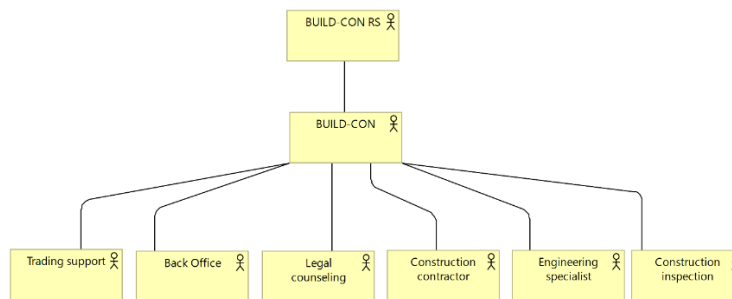



Figure 6. Organization view

The organization view (Figure 6) shows the relationship between BUILD-CON and its owner company BUILD-CON RS, which owns other related business subsidiaries. The business actors that compose BUILD-CON works together to manage different building projects. A business Actor is an organizational entity capable of performing the behaviour. The Business Actor is someone who performs behaviour assigned to a business role. The Actor may be a person, group, department, or business unit (The Open Group 2021).

Table 3 shows the correspondence between the business actor (as an EA component) and PMBOK7 and Star Model.

Table 3. Organization view analysis

EA model: Organization view		
EA component	PM component (PMBOK 7th)	Star-Model component
Business actor Business Actor 	Project team, organizational structure components	Structure; People; Processes

Following Table 3, the business actors can be founded in all project contexts and compose the project team and the whole organization. Moreover, business actors regarding SM could be *people* who compose the organization structure and collaborate in business *processes*.

In the business layer, ArchiMate includes an (ii) Business Function view, which shows the main business functions of an organization and their relationships in terms of information, value, or goods flows (Jonkers et al. 2012). Figure 7 shows each business role's openness and collaboration, describing a set of business behaviours based on business resources and/or competencies closely aligned with an organization (Group 2021).

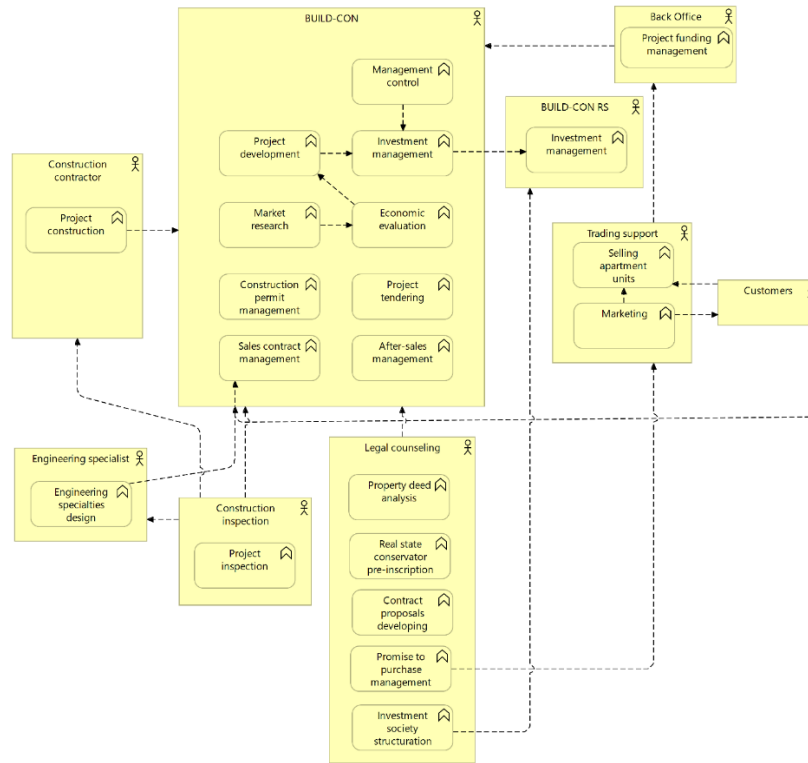
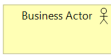
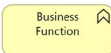


Figure 7. Business function view

Business actors perform the business functions, and, as shown in Table 3, people that perform PM activities can be represented using this nomenclature. Table 4 shows the correspondence between PM components, business actors, and function EA components. Also, these elements are related to the structure, rewards and people SM components.

Table 4. Business function analysis

EA model: Business function		
EA component	PM component (PMBOK 7th)	Star-Model component
Business actor 	Project team, organizational structure components performing some business functions	Structure; Behaviour; People
Business function 	Portfolios, programs and projects with operations (such as payroll, supply chain management, e.g.) work together as business functions to comprise a system of delivering value aligned with the strategy.	Strategy; Structure; Behaviour

The EA business layer encompasses the (iii) business processes. In general, the application of EA in PM is mainly focused on the business layer. The same trend can be found in the EA applications in the AEC industry, mainly based on the need to have a tool to help coordinate the work between different project actors (Atencio et al. 2022 a). In the case of BUILD-CON, there was a certain awareness of the processes and those that contained the activities that made the development of the projects a reality were recognized. However, there was no awareness of how these activities could be interrelated with other processes. To support the process of discovering, the APQC (American Productivity and Quality Center) business process classification framework (PCF) (APQC 2022) was used to identify the activities that were realized and which were not, as well as to locate them in an orderly structure. Figure 8 shows the business process recognized in BUILD-CON, classified into two macro-processes: operating and management and support processes.

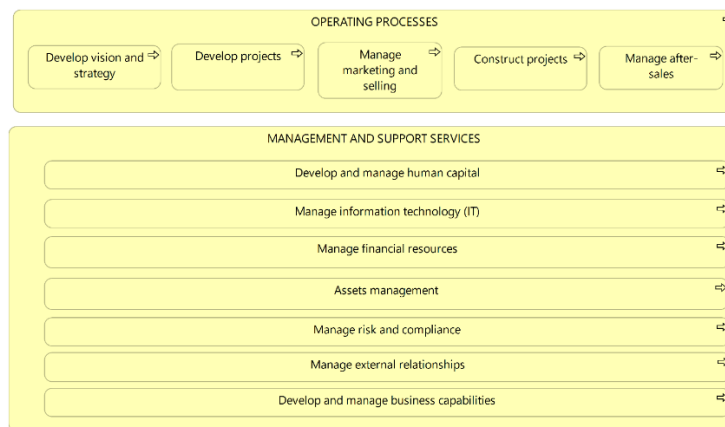


Figure 8. Business process view

For process modelling, the used language represented a concern for users. Users were familiar with flowcharts and had certain maps described in a language similar to BPMN (Business Process Modelling Notation). BPMN is a business process modelling language composed of interconnected elements such as flow objects, data, connecting objects, swimlanes and artefacts (Von Rosing et al. 2014). BPMN models mainly cover business process flow; however, other aspects, such as actors, data objects, and IT elements, e.g. are outside BPMN scope. EA models can represent these aspects through the interrelated view of business processes and other EA layers (Penicina 2013). However, the business process logic provided in the EAs' business layer is very abstract compared with BPMN models.

For this reason, EA and business process models must be linked to address the information system's structural and behavioural aspects (Penicina 2013). Considering these issues, a mix of EA and BPMN language-based models was developed in BUILD-CON to provide a processes landscape that allows maintaining the current models' view familiarity and describing the interrelation between the different EA layers. Not all declared processes were modelled, as shown in Table 5. The missing ones were recognized as such, but their modelling will be done by BUILD-CON at a later stage, considering that currently, these processes are not executed as a group of repetitive activities and are recognized by the users. However, the need to govern them in the medium term is recognized.

Table 5. Business processes models status

ID	Type	Name	Status
1	Operating processes	Develop vision and strategy	Recognized, not modelled
2		Develop projects	Modelled using BPMN
3		Manage marketing and selling	Modelled
4		Construct projects	Modelled
5		Manage aftersales	Modelled using BPMN
6	Management a support services	Develop and manage human capital	Modelled
7		Manage information technology (IT)	Recognized, not modelled
8		Manage financial resources	Recognized, not modelled
9		Assets management	Recognized, not modelled
10		Manage risk and compliance	Recognized, not modelled
11		Manage external relationships	Recognized, not modelled
12		Develop and manage business capabilities	Recognized, not modelled

In the following figures, the modelled processes are presented and analyzed. Figures 9 to 13 contain the modelled processes and their analysis is displayed in Table 6.

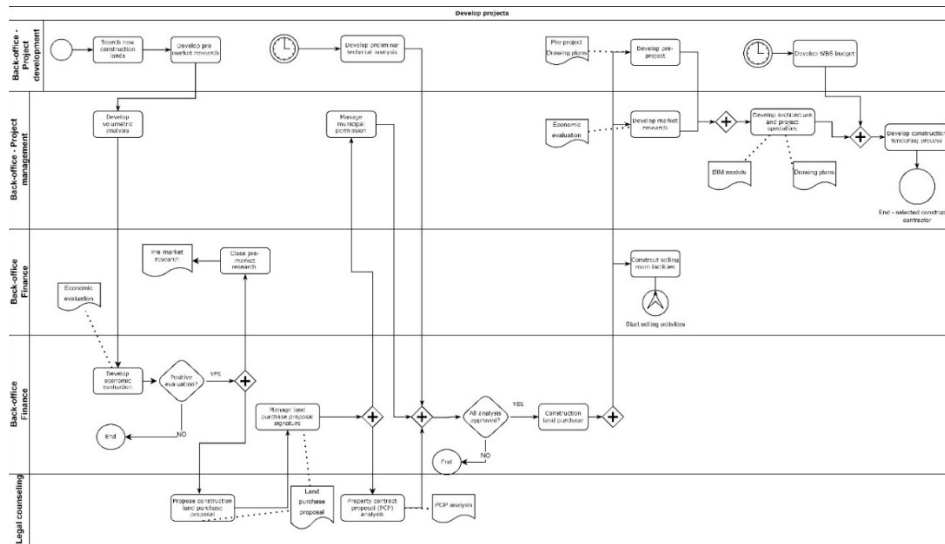


Figure 9. Develop projects - BPMN diagram

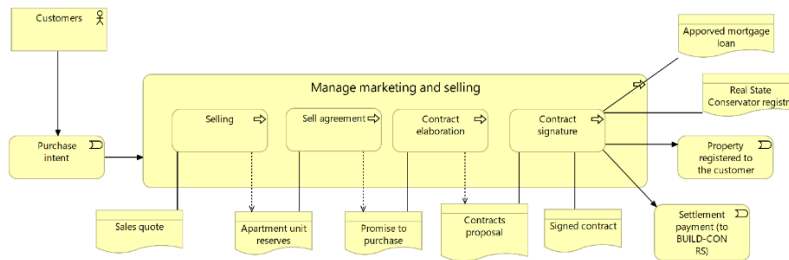


Figure 10. Manage marketing and selling business process

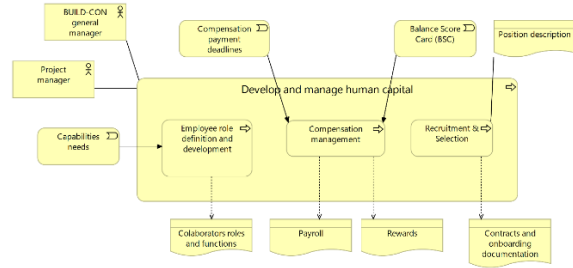


Figure 11. Develop and manage human capital business process

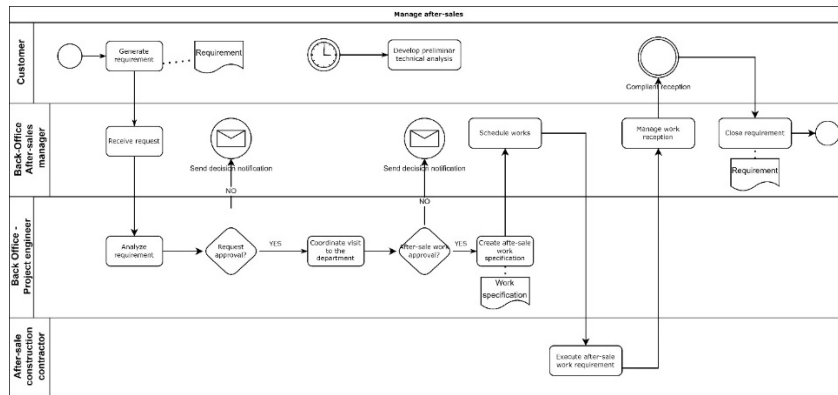


Figure 12. Manage after sales - BPMN diagram

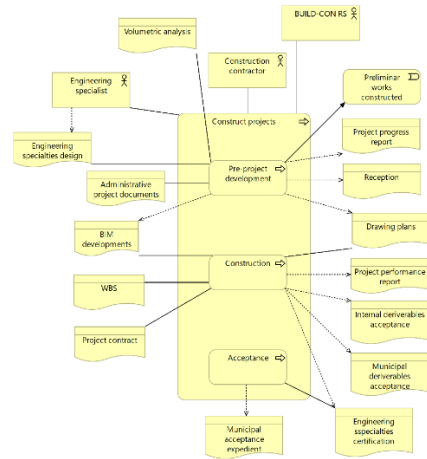


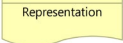
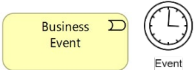


Figure 13. Construct projects - business process

The models displayed in Figures 9 to 10 show different aspects of the business processes related to the construction projects development. The PM elements displayed in all diagrams and their representation in EA language are explained in Table 6.

Table 6. Business processes analysis

EA models: business processes		
EA component	PM component (PMBOK 7th)	Star-Model component
Business actor 	Project team, organizational structure components performing some business functions	Structure; Rewards; Processes; People

Business processes and their activities 	The different activities performed for developing projects.	Processes
Representation 	An artifact is a template, document, output, or project deliverable.	Processes
Event 	An event represents a point of time or a condition that can be triggered by specific action or decision	Processes

As shown in Table 6, all PM components have a proper representation in EA language. Moreover, the models represent four of the five dimensions of the Star Model.

4.1.3 Phase C

Phase C of TOGAF describes the information systems architecture. ArchiMate considers an Application Cooperation view to show an overview of the application landscape and the dependencies between applications (Jonkers et al. 2012). The application cooperation is displayed in Figure 14.

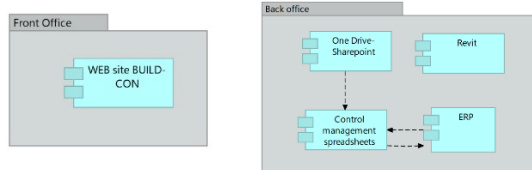


Figure 14. Application view

The application view is divided into front and back office components. The front office application is in direct contact with customers. Back-office application supports business processes. Figure 14 shows that information systems in BUILD-CON are not complex. Moreover, many processes are supported in spreadsheets stored in a OneDrive environment (Table 7).

Table 7. Application view analysis

EA model: Application view		
EA component	PM component (PMBOK 7th)	Star-Model component
Application component	Business application software and project management information systems (PMIS)	Processes

5. Conclusions

The developed case study shows that a PBO can be modelled using EA. Moreover, an EA initiative was developed in a real company under the pseudonym BUILD-CON. This company could be considered a not very complex structure, considering that it does not have more than 15 employees and most of its business processes are supported through external services. Regarding the representation of PM elements, these are deployed in the different business processes and have been modelled using the company's nomenclature. It can be seen that the EA artefact "representation" allows modelling different project artefacts in a general way. However, ArchiMate allows modelling in a more specific way elements such as contracts or products, which follow the following taxonomy (See Table 8):

Table 8. EA artefacts suitable for PM artefact modelling (The Open Group 2021)

Contract	A formal or informal specification of agreement that specifies the rights and obligations associated with a product.
Product	A collection of services, accompanied by a contract/set of agreements, is offered to (internal or external) customers. For instance, a banking account can be modelled using this artefact.
Business Object	The passive element that has relevance from a business perspective. Represent the important "informational" or "conceptual" elements the business thinks about a domain. Example: an invoice.

The organization's decision to implement the first EA confronted it with several definitions. There was some awareness of business processes; some had even been mapped out. However, a group of activities were being developed without recognizing them within a formal process. The adoption of APQC's PCF from BUILD-CON as a reference allowed the general manager to get an idea of where certain activities developed by him and other collaborators should be located. This also revealed the importance of establishing responsibilities, the expected collaboration and the artefacts produced in each process. This is why certain processes were declared in the general process map, and a roadmap was established to formalize them in the medium term.

The analysis was done manually, using the models and comparing the content directly with the PMBOK 7 text and the Star Model. This was not a very complex task considering that the modelled organization was not very complex. However, analyzing more complex models and comparing them with other references could become laborious and perhaps difficult to perform. For this reason, automatic tools for model analysis may be useful. Future studies could use ontologies as an alternative, where both the EA of the business, as well as the knowledge domains of Project management (PMBOK 7, for example) and organizational design models (Star Model) could be generalized in an ontology to then perform an ontology merging to replicate the same analysis developed in this work.

Regarding the Star Model, it can be verified in this work that all its components (strategy, structure, processes, behaviour and people) are present in EA, so preliminarily, it can be mentioned that EA can support the design of a PBO in its models. However, this work is limited to verify the relationship with the component at a general level but does not go deeper at a higher granularity. Similarly, this limitation is replicated for comparing the EA model with PMBOK7. Therefore, the suggested future study on ontology could be extended to a complex business model and to the general domain of EA, Project management and PBO design frameworks, such as the Star Model, and verify their interrelationships.

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*Proceedings of the International Conference on Industrial Engineering and Operations Management
Manila, Philippines, March 7-9, 2023*

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