Organizational Analytics in Enterprise Architecture Development

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Abstract: - Enterprise Architecture (EA) development is considered as consisting of modelling and engineering of enterprises. In both approaches, subject of considerations can be presented as including the following layers: business, information, application and infrastructure. Each of the layers is modelled and constructed in different ways. The paper focuses on the business organization analytics for the EA development. The organizational analytics is understood as business structure, roles, and processes. In general, the EA developers mostly presuppose the process-oriented modelling, however, in this paper, the goal is the business structure models implementations for business architecture development. The proposed approach of business architecture modelling is visualized by the example of non-formal education architecture development.

Key-Words: - business structure, business architecture, ArchiMate, SysML, BPMN, CMMN, DMN, non-formal education.

1 Introduction

The primary need for development of an Enterprise Architecture (EA) is to support the business unit by providing the fundamental technology and reengineering the business processes for the implementation of the Information Communication Technology (ICT) strategy [9], [26]. The business architecture development is important in many aspects, i.e., user profiling, preferences and security modelling, continuous reconfiguration of the organizational resources as well as exploration, exploitation, or outsourcing of business resources. Business organizational structure should be developed not only in the process aspect, but also in the business unit aspects, due to, for example, the personalization of users and their independence of location, so they must be mobile and the ICT architecture is to ensure the mobility and personalization, network organization development instead of the process organization, and virtual organization development where structures and processes are agile.

In the ICT domain, the EA will always support, specify and follow incremental and iterative implementations of information systems. In general, the EA is to be widely accessible for all the business organization members to receive their acceptance as responsive to user needs [1]. Therefore, EA modelling should cover socio-economic aspects, not only technical and technology considerations. For the purpose of the paper, the enterprise architecture is considered in the aspect of business architecture, but the focus is on business structure and business process modelling. The main advantage of the paper is to emphasize the value of business structure models for EA development. The paper consists of two parts. The first part covers literature review of the business structure models, their visualisation and discussion on their value for EA development. The second part is to present the specification and visualisation in Business Process Modeling Notation (BPMN) [24], ArchiMate [2] and Systems Modeling Language (SysML) of a business structure for the non-formal education architecture development [15], [30]. The proposed structure is derived from the applied research methods. At first a literature review was done. Next, the case study approach was used. So, taking into account a personal experience, author proposes the business analytics approach and usage of ArchiMate language, as well as the information system requirement specification in SysML language. Finally, the non-formal education events are modelled in Case Management Model and Notation (CMMN) notation, which is just suitable for cases analyses and modelling [23]. Additionally, a decision making problem was visualised in Decision Model and Notation (DMN) notation diagram [25]. Anyway, the Visual Paradigm software tool is considered to be the most suitable for information system analysis and modelling. However, here different tools, i.e., ArchiMate (https://www.archimatetool.com/), Bizagi (https:// www.bizagi.com/ en/products/bpm-

suite/modeler), Visual Paradigm (https://www.visual-paradigm.com/ and Camunda (*https://camunda.org/ download/ modeler/)* were applied.

2 Business Organization Models

ISO/IEC/IEEE 42010-2011 standard of Systems and software engineering-Architecture description is the fundamental organization of a system consisting of its components, their relationships to each other and to the environment, as well as the principles guiding its design and evolution. The EA as a product should serve managers to support the design of business structures and processes, and system developers to help in building applications in line with business objectives, policies, and principles [20]. The similar intentions are provided by Sandkuhl [28]. They argue that the most important perspectives in enterprise modelling cover the goals and problems, the business processes, the organization structures, the technical components, the products, the concepts, and the business rules perspectives.

The term "enterprise" is defined as an overall concept necessary for identification of a business company, university or governmental institution. The enterprise business structure recognition helps a business organization to establish technical guidelines of how the service delivery function needs to operate to deliver cost-effective, flexible and reliable business services. Within an enterprise, business units can be recognized. They are identified with particular individuals or their groups and considered as fundamental building blocks in business organization structure [13]. They are created to achieve the socio-economic benefits in serving a selected target product in market segments.

2.1 Structure vs. Strategy

Chandler's idea that "structure follows strategy" is well known in the domain of organizational formulation. Chandler [5] argues that organizational structure is needed for strategy realisation, particularly one of the following: volume expansion, geographic dispersion, and vertical integration. Chandler explains his approach by the example of a start-up firm in a single location and with a single business function. The first simple strategy emphasized by the manager is volume expansion, which leads to a simple structure where an administrative office is established to manage the business. The next simple strategy is geographic dispersion, which results in adding a distribution department headquarters to administer the several distributed business units. The last strategy is vertical integration, which adds additional functions to develop a new business. So in that way, each strategy has got an impact on the business structure and performance [12].

2.2 Business Structure Modeling

Generally, business modelling is oriented towards mapping, abstracting and a usability emphasis. The EA is modelled to be constantly renewed, because of the ICT development. However, there are other reasons, which are equally important for enterprise modelling as well as for enterprise design. In the design theory the following characteristics are defined: purpose and scope, form, principle and description of the EA artefacts, artefacts mutability, i.e., anticipation of the changes in artefacts, as well as testable propositions, principles of implementation, and expository instantiation for successful prototyping [18].

The business structure modelling is derived from principles that are based on empirical deduction of observed behaviour or practices. Similarly to requirements, principles define intended properties of the enterprise architecture [28]. Scientific principles are cross-disciplinary and can be applied in different design domains. They are laws or facts of nature underlying the working of an artefact. The EA principles can be descriptive, explanatory, predictive or prescriptive [17]. Business principles and EA principles are formulated not only in scientific research, but also in the empirical processes. Particularly, business analysis is a set of activities that support discovery and creation of business and system architecture principles. The business analysis as an empirical process is realized by defining the needs and recommending solutions that provide value to stakeholders. Business analysis approaches may be defined by scientific methodologies or by *de facto* organizational standards.

2.3 Business Model Review

Business organization models are simple and stable views of an entire organizational system, i.e., its structure, relationships among structure units and their activities. They can present the organizational system dynamics, the power of decision making and responsibilities, and the value of the messages. The organizational system design is focused around human beings and their needs, and also around their communication. Business organizations, at first glance look almost the same, because of the implemented software and respecting the same legal acts, however, in that organizations people perceive

things differently and interpret the world in different ways, so eventually they would have different goals, value propositions, interpretations of roles and job descriptions, different approaches towards rewards, peer recognitions and personal career advancement. However, in spite of that, certain generalizations are possible. Table 1 includes five business structure models, which particularly focus on organizational components and relationships among them. The ontology of that models is presented in Protege (*https://protege.stanford.edu/)* tool.

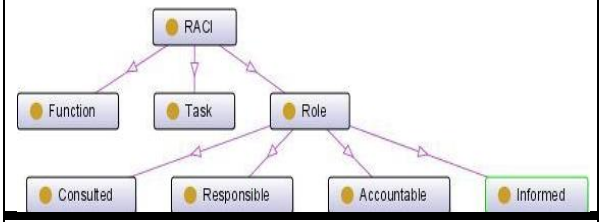
Table 1 Business Structure Models and their semantic visualization

RACI Model

Original Representation

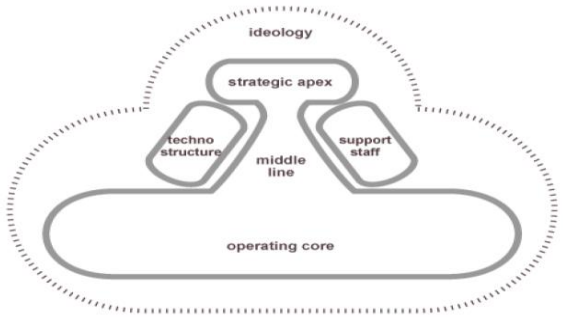
	Role A	Role B	Role C	Role D
Function/task 1	**R**	**A**	**C**	**I**
Function/task 2	**A**	**R**	**C**	**I**
Function/task 3	**C**	**R**		**A**
Function/task 4	**R**	**C**	**I**	**A**
Function/task 5	**I**	**A**	**R**	

Semantic Net



Mintzberg Structure in Fives

Original Representation



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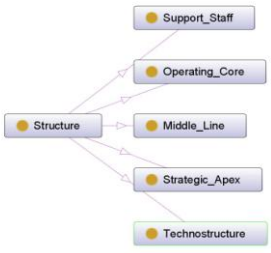
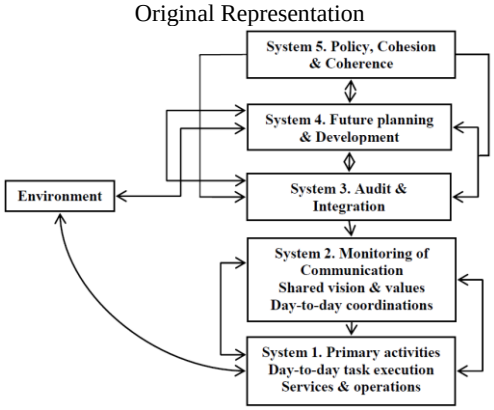


Viable System Model

Original Representation



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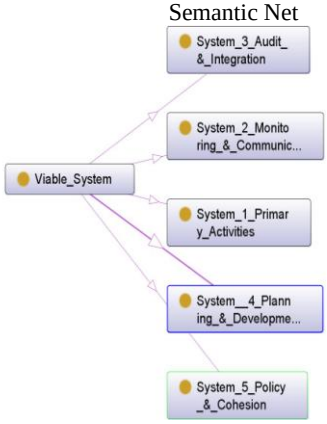
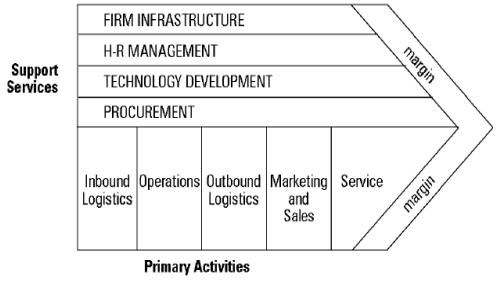


Value Chain Model

Original Representation



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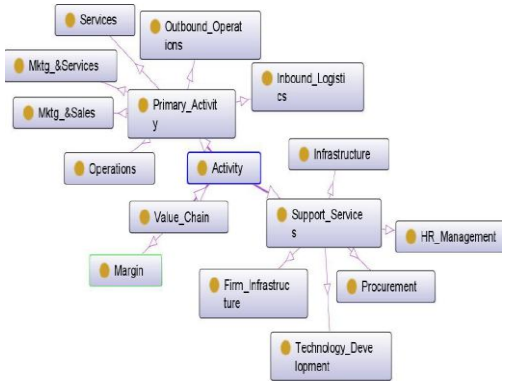


The RACI model determines those who are responsible (R), accountable (A), consulted (C), and informed (I) for a set of business fields such as objectives, risks, projects, and processes (Table 1). In the empirical application of that model, organization designer is requested to specify who in the business unit's structure is responsible, who is accountable, consulted, or informed. There are some versions of RACI model, e.g., RASIC, where the S stands for Support. The RAPID model is a framework based on the following: Recommend, Agree, Perform, Input and Decide. In the RAS model, the R stands for Responsible for outputs or end results, the A means Approve, veto power on a decision and sign off actions, and the S is for Support and providing information and analysis to the responsible person [22].

Developed by Mintzberg in 1983, the organizational model is enduringly actual [21]. The structure of an organization is defined as consisting of five parts, mutually dependent and coordinated (Table 1). At the bottom of a business organization hierarchy, the operating core encompasses the members who perform the basic work related directly to the production of goods and services. At the top, the strategic apex is charged with ensuring that the organization serves its mission in an effective way, and it serves the needs of those who control or have power over the organization. The middle line is to support the coordination in case of lack of direct supervision, and also they are responsible for the order transfer from the top to the bottom, and the flow of reports in the opposite direction. The technostructure includes the analysts and experts who serve the organization by affecting the work of others. They may design work of others, plan, train the people and control their activities. Support staff is responsible for tasks outside the main business process of the organization. These are specialists of legal counselling, public relations, payroll, reception, or mailroom.

According to Yolles, viable systems (Table 1) have structures that support and constrain their behaviour and beyond that, they have metasystems that are responsible for the maintenance and extension of that structure [31]. A business organization is considered as viable if it has a set of identified management systems S1-S5, with a specific set of interrelationships. The Production System S1 consists of various divisions and they have their own relations with the relevant units of the outside world. The Coordination System S2 covers the various rules and regulations that ensure the S1 parts act cohesively and correctly. The Audit and Integration System S3 is to check on performance, quality and conformance to financial regulations and maintenance. The Development System S4 is to collect for the organization all relevant information about its overall environment. The Policy, Cohesion and Coherency System S5 is responsible for decisions of the whole enterprise. It formulates policy on the basis of the information received from System S4, and communicates this policy down to System S3 for implementation by the S1 divisions. The structure of a viable system is formulated to ensure the easiness of the system controlling as well as the system's stability, coherence and optimization of management activities.

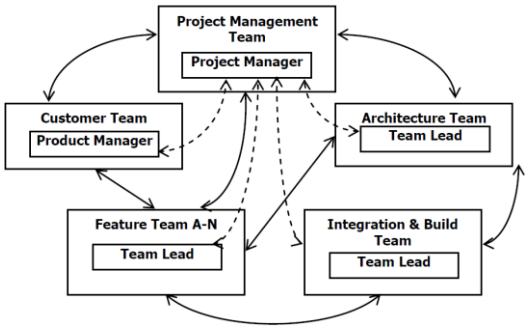
The value chain model (Table 1) proposed by Michael Porter consists of elements, each of them identified as a particular department in a company. Taking into account the value chain model, each business organization has to consider which activities will be realized internally (i.e., insourcing) or taken over by outsourcing. In that way, they can further consider ICT investments only for divisions developed internally, i.e., insourced. In analysing the strategic alliances and mergers and acquisitions deals, the value chain is often used to get a quick overview of the possible match, because one company might be strong in logistics, the other - in sales and services [6].

All the models in Table 1 focus on divisions within business organizations. These divisions' specification and the whole organization design depend on product market strategies, business strategy, economic constraints, local culture, coordination principles and business agility. So, for the EA development these models are customized. Beyond that, the project-oriented business organization adopts business structure models more suitable for them, e.g., a hub model, Prince2 model (Table 2).

Table 2 Project-oriented Business Structure Models and their semantic visualization

Hub Organization Structure

Original Representation



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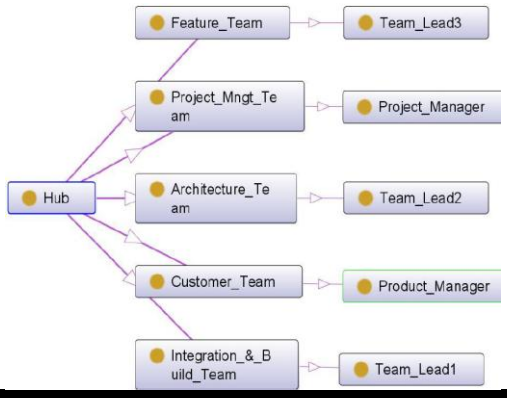
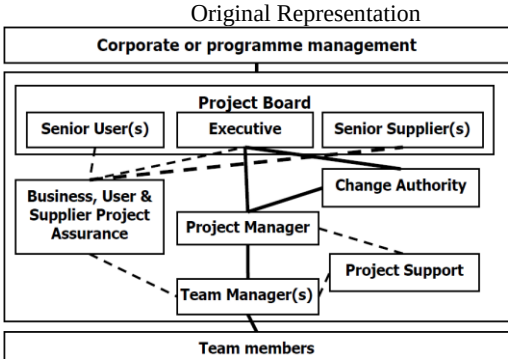


Prince2 model

Original Representation



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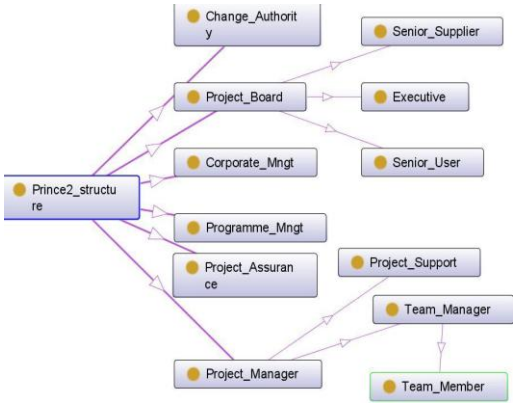
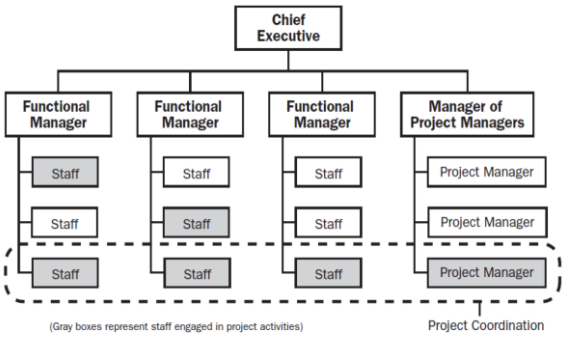


PMI matrix organization

Original Representation



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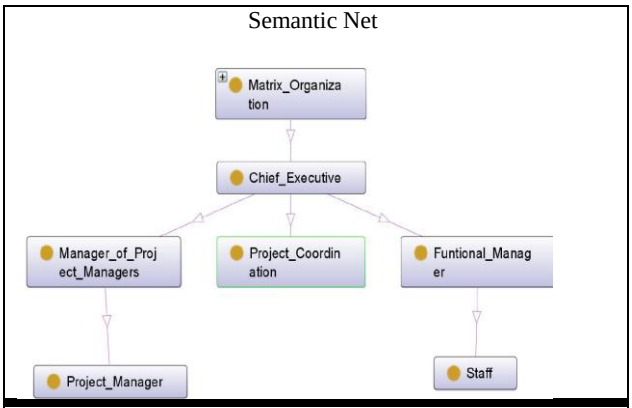
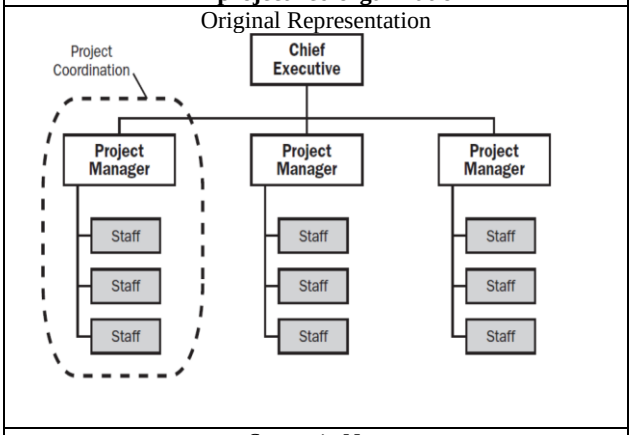


PMI projectized organization

Original Representation



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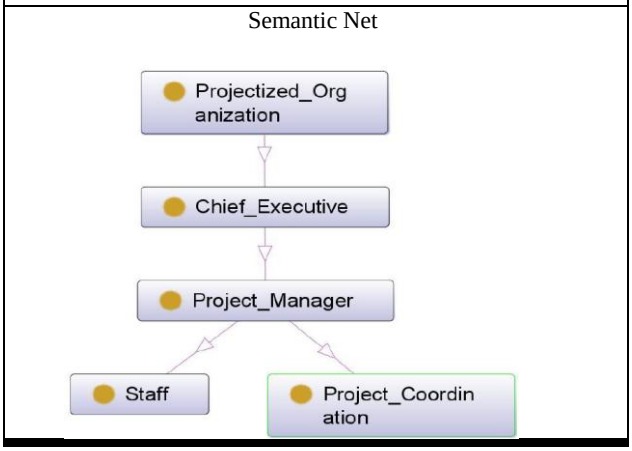

A Hub Organization model for project organizations reflects a hierarchical structure [16]. Each node is a business unit within the project organization. The teams specified in Table 2 can be offline, virtual or mixed. The team building to further support them with ICT is a challenge for the business architect.

Prince2 project management method includes a unique model of project management team structure (Table 2) [14]. In general, a project is assumed to be developed within a corporate or programme structure. The Project Board contains the roles of Executive, Senior Users and Senior Suppliers. Executive is the key decision maker accountable for the project's success. Senior user has to represent the interests of all the users on the project board. Senior suppliers represent supplier interests and

they are accountable for the product provision. The project board cooperates with other project teams, e.g., project assurance, management, and support (Table 2).

Project Management Institute (PMI) proposes some different business structure models for project-oriented organizations (Table 2) [27]. Strong matrix organizations have many features of the project-oriented organization, and have full-time project managers with considerable authority and full-time project administrative staff. According to PMI, in projectized organization, all the organization's resources are involved in project works. Project managers have an internal independence and authority, however they compete among themselves for the resources. The general PMI models in practice are customized and include the local principles and practices.

3 Business Architecture Modeling for Non-Formal Education

As it was mentioned at the beginning, the goal of the paper is to visualize the non-formal education architecture. According to Dumitrescu, non-formal education is a support activity in the lifelong learning process [4], [11]. Among others, it can be carried out within companies, by professional associations, or by self-motivated individual volunteers.

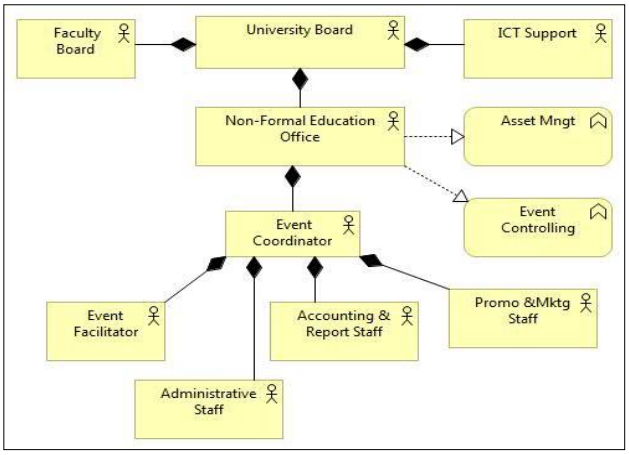

Fig. 1. Non-Formal Education Business Structure Model.

Presented in the paper, non-formal education business structure model is visualized in ArchiMate 4.0 language (Figure 1) [9], [19]. In the presented in Figure 1 business architecture model, the non-formal education is assumed to be realized within a university institution, so university staff and students are involved in the educational processes as organizers as well as the beneficiaries of the educational process results [1], [7]. The non-formal education is assumed to be realized as a system of events and the event management methods can be applied to cope with them. The event management business structure is similar to the project management business structure, because the basic characteristics of events are very similar to the project dimensions [3]. So, the event is defined as a set of activities realized in an established period of time, within a certain budget and by a group of event organizers. There is an event coordinator, who plays a similar role to a project manager. However, for event management it is necessary to employ an event facilitator [4]. This role covers:

- giving and seeking information and opinions;
- proposing goals and suggesting ways of initiating actions;
- giving directions and developing plans on how to proceed;
- summarizing related ideas, suggestions and discussions;
- linking ideas and activities by relating them to each other;
- evaluation of alternative solutions, and applying them to real situations;
- monitoring and supporting the non-formal education process;
- reducing risk aversion;
- persuading and supporting people to reconcile disagreements.

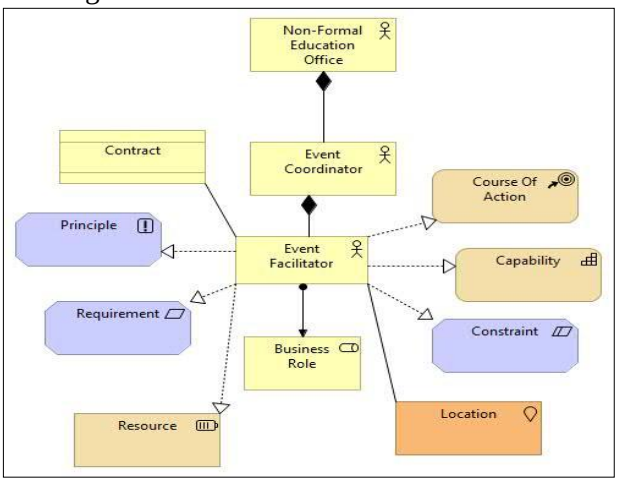

Fig. 2. Non-Formal Education Event Facilitator Profile Model

Taking into account the presented above tasks of an event facilitator, it would be possible to model their profile, which could be further utilised in the business and application architecture models. In general, the event facilitator's profile should covers not only their personal data, but also the course of realized actions, capabilities and constraints, business role, location, available materials and financial resources, contract, principles and

requirements concerning information systems for the event controlling.

The ArchiMate language allows only for a very general outline of business processes and system requirements. Therefore, the requirements of information systems for non-formal education support are visualized in SysML Requirement Diagram in Visual Paradigm version 14 (Figure 3) and the non-formal education business process model is visualized in Business Process Modelling Notation (BPMN) language (Figure 4) [9], [24]. The SysML Requirement Diagram is a useful tool for recording, describing and organization of functional and non-functional (i.e., performance and interface) requirements of a system [15], [30]. The SysML Requirement Diagram is considered as the primary for communication among users and system developers. They commonly create requirements diagrams to ensure traceability from requirements to system structures and behaviours [8], [10], [15].

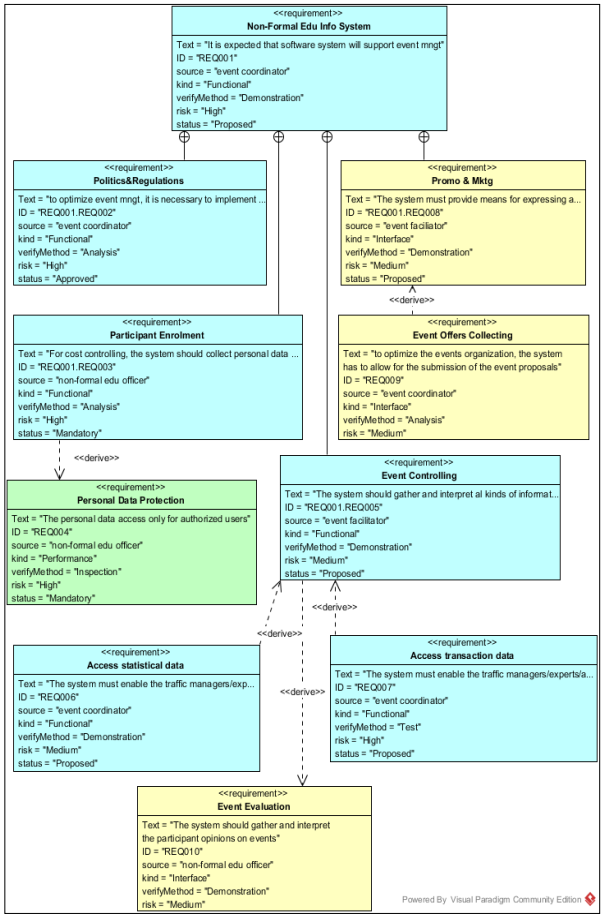

Fig. 3. Non-Formal Education System Requirements

In Figure 3, from the functional requirement "Event Controlling" two functional requirements are derived, i.e., "Access statistical data" and "Access transaction data". From the interface requirement "Event Offer Collecting" the interface requirement "Promo&Mktg" is derived. The requirements, i.e., "Politics&Regulations", "Participant Enrolment", "Event Controlling" and "Promo&Mktg" are parts of the functional requirement "Non Formal Edu Info System", which is the top requirement about that software system is expected to support the non-formal education event management. The performance requirement "Personal Data Protection" is dependent on the functional requirement "Participant Enrolment". The interface requirement "Event Evaluation" is derived from the functional requirement "Event Controlling".

The requirements can be easily verified with test cases and supported by other SysML diagrams as well as the RACI model diagram and BPMN models for business processes. The non-formal education events may have characteristics similar to project dimensions, i.e., learning objectives, time, financial and human resources, location, risk, benefits, long-term impacts, audience, publicity, promotion. The event management process is modelled in Figure 4.

Similarly, as for projects, the event life cycle consists of the following activities: organizing, analysis, identification, evaluation, design, promotion, realization, and shutdown. There are also some differences among projects and events. Usually, events have a wider audience, which cover recipients of the services provided within the events. Projects are oriented towards the delivery of material products, artefacts and accompanying services.

In Figure 4, the Non-Formal Education Business Process includes a subprocess on the Establishing the Event Vision, which is critical task group. Therefore, it is extended in a separate CMMN model in Figure 5.

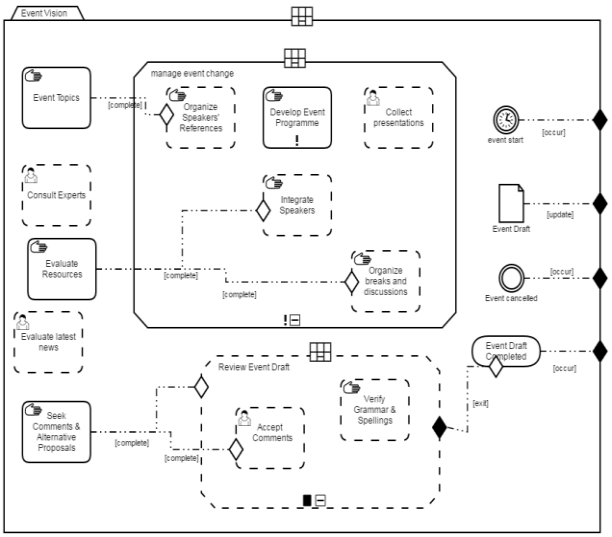

Fig. 5. CMMN model of the subprocess Event Vision

The CMMN model is to be considered as a declarative approach, just to specify what should be done to ensure the required success for the BPMN business process.

However, beyond the Event Vision subprocess, for Non-Formal Education Strategy the strategic option considerations and a particular decision making model application are also critical. The Non-Formal Education can be financially supported by inter-organizational sponsors or by external donors. It can be developed at university or any location. Learners participate in webinars online or in seminars offline. Therefore, the event facilitators and coordinators have to consider many different alternatives. The necessary decisions for Non-Formal Education development are included in DMN model in Figure 6. The DMN notation includes only four elements, i.e., decision, business knowledge, knowledge source, and input data. The decision component can be further precisely detailed, however then additional modeling tools are needed. All DMN elements are interdependent. The dependencies between these four elements present three kinds of requirements: information, knowledge and authority [25].

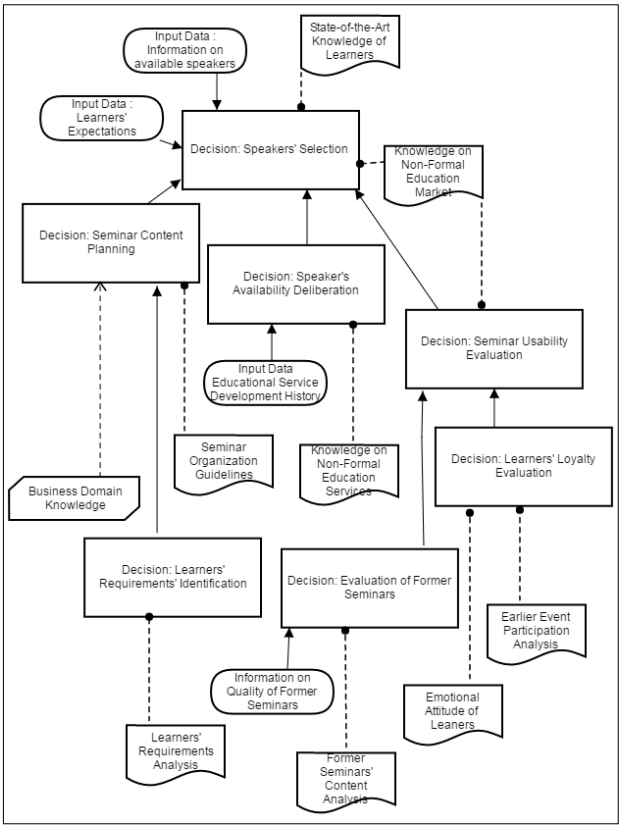

Fig. 6. Decision Making Model for Non-Formal Education Development

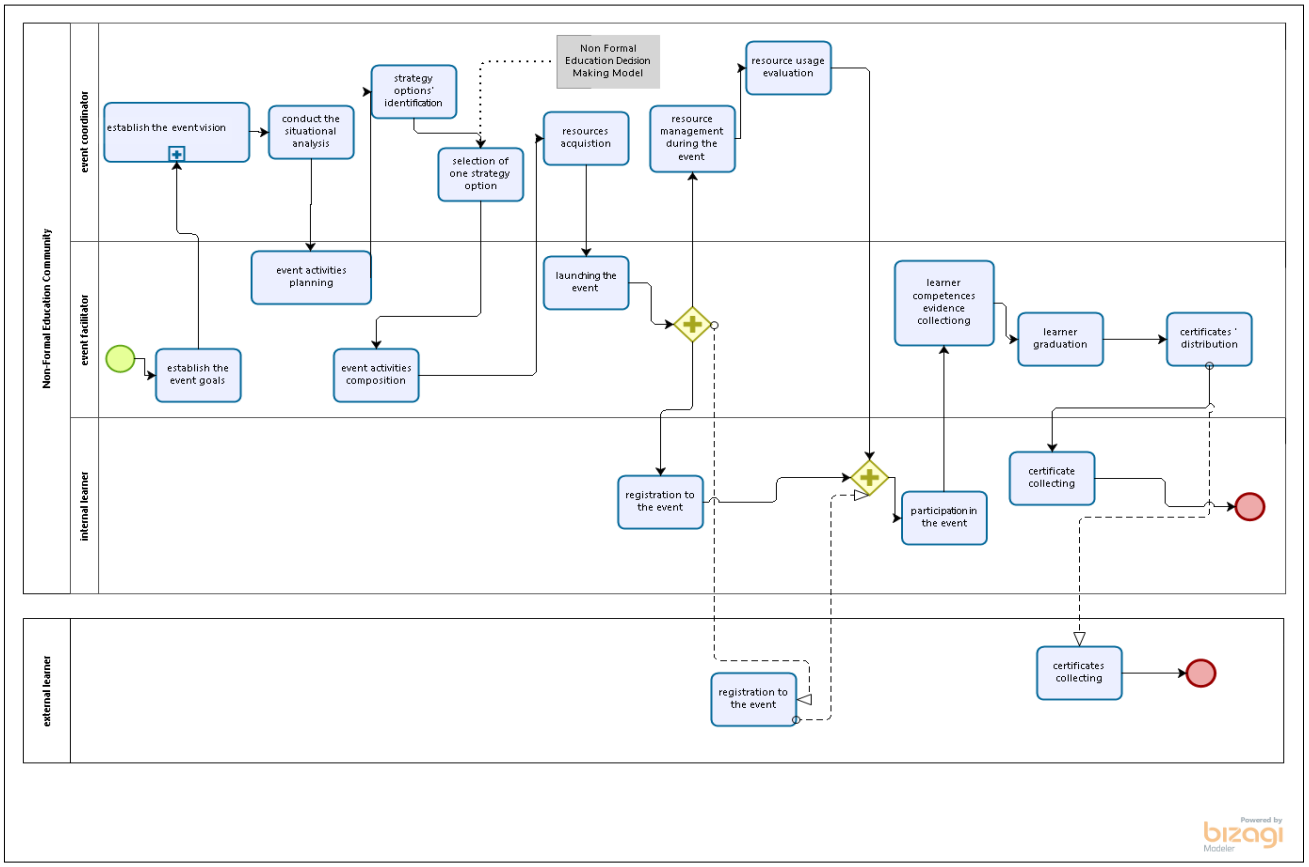

Fig. 4. Non-Formal Education Business Process Model

4 Conclusion

In general, the paper emphasizes the necessity to take into account the classic business models for EA modelling. The Business Architecture model includes business processes, but the business structure modelling is equally important, as it is in the classic approaches, i.e., M. Porter' model. The business structure models are available in research studies as well as developed in practice. The non-formal education events can be realized similarly to the projects, so the similar business structure models can be applied. The paper presents models of event management team and particularly focuses on the characteristics of the event facilitator, who is the most important participant for the non-formal education success. Beyond that, the business process is modelled and finally the requirements for the event management information system are specified. The paper presents an applicability of the SysML diagram for business information system modelling. The presented diagrams are complimentary and cohesive, although there is no a special meta-model, which covers all of them.

The business analysis software tools used in the paper are selected as compatible and comparable. The high level, strategic considerations can be supported by ArchiMate language and tool. However, the Visual Paradigm tool includes ArchiMate language modelling, as well as business process modelling. Although, Visual Paradigm is the most suitable software tool for business analytics, there are relatively new diagrams, i.e., DMMN models and DMN models, which are not supported by Visual Paradigm. The Camunda modeling tool is appropriate for CMMN and DMN diagramming. The DMN diagram is not focused strictly on the decision making process, but rather on knowledge sources and business information specification, which are necessary for the decision making. Therefore, the DMN diagrams are also need to be supported by other languages diagrams, e.g., SysML diagrams.

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