Teaching Case
Enterprise Architecture Specification Case Study

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ABSTRACT

A graduate course in enterprise architecture had a team project component in which a real-world business case, provided by an industry sponsor, formed the basis of the project charter and the architecture statement of work. The paper aims to share the team project experience on developing the architecture specifications based on the business case of an accountable health care organization. Students collaborated as a team in various roles to develop the architecture specifications for a new business initiative of the sponsoring organization, XYZ ACO. The teaching case describes the case study approach and the architecture approach adopted for the architecture process, and is accompanied by Teaching Case Notes which provide a selection of the models developed by members of the project team towards the architecture specifications. The course started with coverage of enterprise architecture theory, best practices and standards, and the team project gave students the opportunity to apply their theoretical knowledge and "learn by doing". Students were challenged to interpret the business case, the project charter and project requirements, and each team member was allocated an architecture viewpoint and a role to play. The Teaching Case presents a summary of the team project and the lessons learned in performing the project.

Keywords: Design specification, Architecture, Process improvement, Modeling.

1. INTRODUCTION

Developing enterprise architecture (EA) specifications for an enterprise is a non-trivial task, especially in the ever changing business and technology environment of today. In the case of health care organizations the complexity of their business operations have escalated as new legislation has been introduced, and there is increasing demand for improved quality of health care services including Medicare services, and reduction in health care expenditure. Health care organizations are also challenged by their competitors, and must leverage all their assets to survive and prosper. Emerging information technologies offer opportunities to achieve such goals, but there are also significant challenges such as disparate systems in use, concerns such as ease-of-use, transparency, accountability and security, to name a few.

Project-Based Learning (PBL) engages students to apply academic knowledge to applications in the real world. It has been found that PBL stimulates student learning by using acquired knowledge for applied learning (Rivet & Krajcik, 2004; Steenkamp, White & Kakish, 2002). Team-based student projects have become common in coursework in the field of Information Technology (IT), as reported by many authors including Meyer (2005) and Stephens (2001). In a literature survey of student team effectiveness Stephens (2001) has found that there is a need for effective teamwork management in the academic context. A standards-based approach to team projects has been followed by the senior

author over many years, where teams are informed by international standards and best practices in IT projects.

In this paper a case study format was used, after Cappel and Schwager (2002), to report on experience in a team project for a graduate course in enterprise architecture (EA), and falls in the category of a project-based case. For background, the goal of the graduate course was to provide a comprehensive perspective of enterprise architecture within the context of the global business environment of a competitive enterprise. Intended outcomes for the course were that students are able to

- Identify, interpret and adopt the best practices in the field of IT architecture design and deployment as promoted by international standards organizations.
- Lead and manage the process of IT architecture design within the organization.
- Participate in architecture design project as lead designer.
- Define the viewpoints and views relevant to stakeholders, and design models of the enterprise architecture.

The course was offered in blended mode of delivery requiring that teaching and collaboration be done in both face-to-face and virtual modes. The pedagogy was designed to incorporate various didactical methods suited to the adult learner, and requiring higher-order cognitive skills such as the application of concepts and theories, analysis of the business case, synthesis of concerns and principles as relevant for the deliverables of the project, and evaluation of alternative models (Bloom et al., 1956). The pedagogy also recognizes the importance of problem solving and interpersonal skills and communication that are valued by academia and practice alike (Tang et al., 2001). The course started with covering the theory and best practices of EA, during which students executed individual home assignments as part of the course requirements. Orientation was provided for these assignments and detailed feedback on student papers followed after grading them. Part of the course involved an industry sponsored team project which commenced after a substantial part of the EA syllabus had been covered. The team project exposed students to a real-world situation, challenges and concerns and a "learn by doing" experience. Team members were required to collaborate in various roles relating to the architecture process, starting with the interpretation of the business case, the project charter and project requirements. Working on a team project gave the small class of students experience to work on a sizable project in the limited period of the academic term, and was complementary to some theory-based individual assignments mentioned earlier. In addition the team project offered students the opportunity to apply standards and best practices in EA and team management.

The paper aims to share the team project experience in the course when developing the architecture design specifications based on the real-world business case of an Accountable Health Care organization, here called XYZ ACO Inc. With the urgent need of affordable healthcare in the United States the opportunity to collaborate with the project sponsor was regarded as opportune and appropriate. Sections of the paper include the case study approach followed, the architecture approach adopted, and some models of the Enterprise Architecture Specifications, and concludes with a summary of the lessons learned in performing the project. The paper is complemented by Teaching Case Notes (Steenkamp et al., 2012) with additional models developed by the teams that are available on request.

2. CASE STUDY APPROACH

A project-based case, also called a "systems solution case" (Cappel and Schwager (2002), requires sustained involvement of all stakeholders to meet the requirements, and is particularly suited for IT and IS courses such as IT architecture, networking, systems analysis and design, programming, and systems development, as reported in several papers by the senior author, and also by others (Hogue, A, Kapralos, B. and Desjardins, F., 2011). This system solution case reports on an initiative relating to the Health Care Delivery System of XYZ ACO Inc. The project work and architecture tasks focused on developing the EA Architecture Specifications during the Planning and Analysis stages of the architecture process, and are described in Section 3. XYZ ACO's mission, strategic direction, core principles and requirements for the new XYZ ACO architecture initiative were provided by the XYZ ACO sponsor, and along with the course's teamwork assignments stated in the project charter, framed the team project requirements.

2.1 XYZ ACO Inc. Business Case

XYZ ACO was formed in a partnership between the XYZ ACO Hospital and 10 Provider Groups consisting of approximately 920 physicians, 630 independent specialists, pharmacies, and laboratories. The XYZ ACO mission is to improve the quality of health care services, including Medicare services, and reduce the growth in health care expenditures. It aims to achieve this by providing coordinated high quality care services, and to introduce economies of scale in negotiating one contract with all the payers on behalf of all the groups of the enterprise. As part of the XYZ ACO Strategic vision a new approach was formulated to provide quality healthcare while managing healthcare for private patients in the USA. The intent has been to create an accountable care organization using a novel care delivery model which would comply with, and be governed by, the Affordable Care Act of the Centers for Medicare and Medicaid Services (CMS). The Affordable Care Act includes a number of provisions designed to: improve the quality of Medicare services; support innovation and the establishment of new payment models in the program; better align Medicare payments with provider costs; strengthen program integrity within Medicare; and put Medicare on a firmer financial footing. In addition to improving quality, XYZ ACO's initiatives seek to reduce escalation of health care expenditures. It is widely recognized that the current trajectory for the nation's health care spending is unsustainable. Medicare beneficiaries share the burden of rising costs, as they pay higher premiums and larger cost-sharing.

The XYZ ACO Group has now been operating independently for three years, and despite strong leadership each business entity is still separately managed and accounted for on separate balance sheets and healthcare contracts, making profitability a challenge. Corporate

concerns include:

1. There is no clear concept of 'Member (Patient)' across the group. Recent privacy legislation complicates use of Member information in any case, and an analysis is required of these implications, for preparation of a privacy statement.
2. Financial reporting is required, at least on a monthly basis, to be of operational and tactical use. There is no visibility across all units to manage cost and provide high quality care.
3. There is no comprehensive business architecture on which to base and manage operations of the group as a whole.
4. Hospitals use different application packages.
5. Each business within the group uses different application packages. There is no basis for achieving economies of scale in materials and resource purchasing or management, neither for cost management nor for cross-selling services to identified customers.
6. The infrastructure currently does not support operations within an integrated business model.
7. XYZ ACO uses a range of IT Practice Management Systems, and since the group's mission is now primarily towards profitable managed health care this diversity of systems presents a major flaw in the data and business architectures, as no ready measures of income per member are available across the group.

Figure 1 shows the XYZ ACO Business Capability Map for management of categories of services provided by the project sponsor (ACO Inc., 2012). IT support was found to be at Level 1 Capability, and the EA Project described in this paper is one of the initiatives to improve this capability.

Key factors for successful implementation and operation of the intended accountable care organization using the new care delivery model were provided in the business case. These include care management, financial and performance analytics, predictive modeling, electronic medical records, quality reporting, data warehouses, evidence guidelines and care protocols, provider profiling and network management, and are to be implemented by XYZ ACO. The team project focused on scheduling, reporting and performance management.

2.2 Project Charter

XYZ ACO Inc. realizes it cannot deliver the strategic vision and address the above mentioned concerns with the current EA and business capability, and are planning to implement its future EA in several project releases. With agreement from XYZ ACO Management the project sponsor presented a Request for Architecture Work to the EA Project Team outlining the project charter. The team interpreted the requirements in terms of a Statement of Architecture Work document using the template in Table 1, which includes hints for using the template.

The project charter defined the deliverables for the team assignments of the course, as well as the scope of the EA initiative to be undertaken for XYZ ACO.

Deliverables for Project. The key deliverables were the Architecture Project Plan and Statement of Architecture Work document for the sponsored EA initiative described in Section 2.1; architecture principles derived from the concerns stated in the Business Case; architecture analysis for each of the allocated viewpoints; and the Architecture Specification Document.

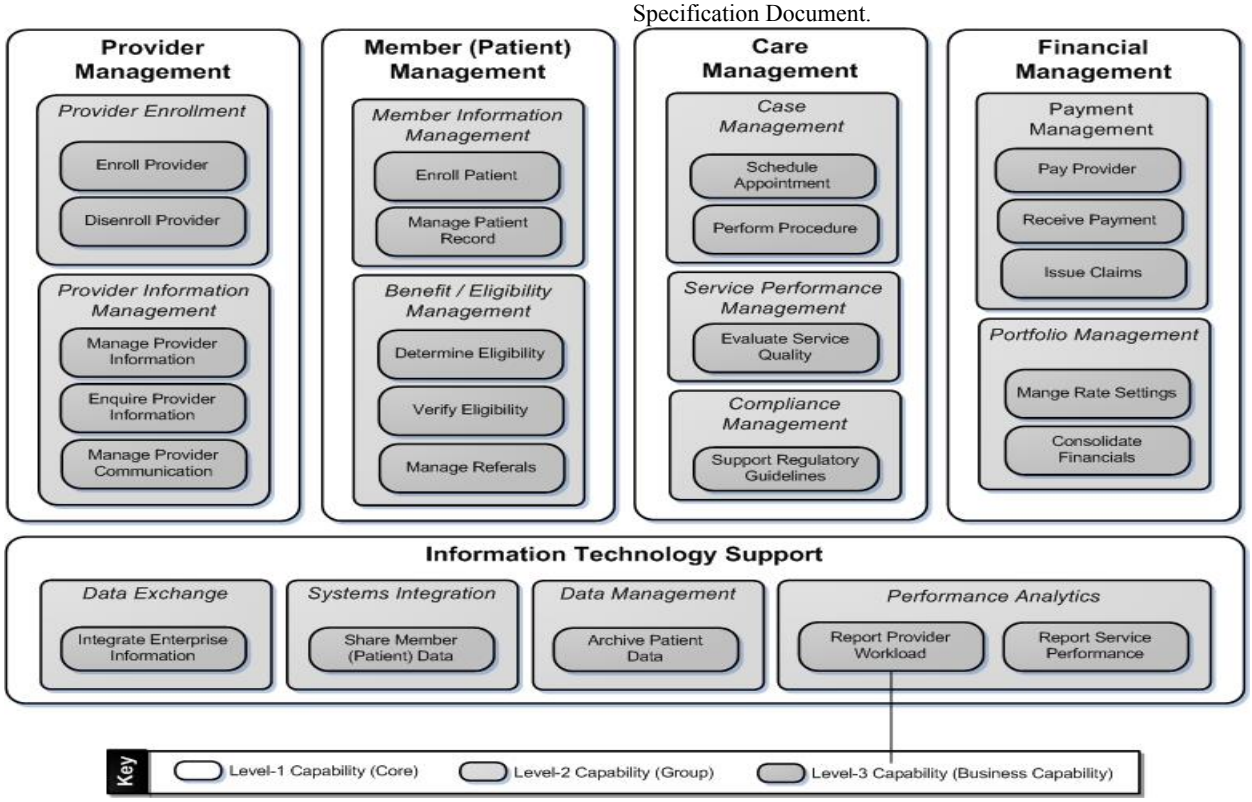

Figure 1. XYZ ACO Business Capability Map (ACO Inc., 2012, pp.5)

Statement of Architecture Work (SAW) Template

Statement of Work title (Hint: Keep it precise and informative; avoid meaningless project names)
Project Request and Background (Hint: 25 words or less stating the issues)
Project Description and Scope (Hint: Usually determined by scale and complexity of the enterprise itself. The key is to understand what can realistically be achieved with the available resources and competencies; focus on delivering achievable value; this should cover: 1. Horizontal scope, i.e. the breadth of enterprise area to be covered, E.g. business functions, locations 2. Vertical scope, i.e. the level of detail that will be created for each domain. E.g. conceptual, logical, physical for business, applications, information or technology
Architecture Vision (Hint: Just a statement is needed)
Managerial Approach (Hint: What is the approach?: Conventional whole of business architecture covering detailed current and target architectures; Segment approach using a high-level conceptual framework with detailed future architecture focusing only on major business areas)
Change of Scope Procedures (Hint: All change requests of any type may be funneled through one consistent Change Management Governance process. Many companies adopt ITIL processes for this)
Responsibilities and deliverables (Hint: include a table)

Roles	Responsibilities	Deliverables

Acceptance criteria (Hint: include a table)

Criteria	Procedures
Compliance with RAW	Compare RAW-SAW for consistency
Additional criteria	Additional procedures

Project Plan and Schedule (Note: This is usually a Microsoft Project plan based on a standard EA template. For this assignment you are only required to identify 5 or 6 steps and estimate percentage of effort)

Steps	Tasks	Percent Effort
1 - 6	1 - ….	

Table 1. Statement of Architecture Work Template

Scope of EA Initiative. In accordance with the purpose of the EA initiative for XYZ ACO Inc. the project team was charged to develop the Architecture Specifications that address specific concerns relating to accountable and affordable health care as part of the group's strategic vision stated in Section 2.1. The scope of the project was constrained and governed by the business drivers and concerns as defined in the Architecture Statement of Work (refer Table 1). A complete list of concerns and principles are provided in the Teaching Case Notes, Table 2 along with descriptions, rationale and implications of each. XYZ ACO's key architecture principles are summarized in the list below:

Principle 1: Improve care quality and access to health care

Principle 2: Affordability - reduce the cost of health services

Principle 3: Provide Information transparency among participating businesses and stakeholders

Principle 4: Design must promote reuse within and among XYZ hospital chain

Principle 5: Provide a flexible balance in complexity, manageability and performance

Principle 6: Components must maintain high cohesion and a low coupling

Principle 7: High Security of information, business systems, data, application and infrastructure

The EA initiative is to be implemented in several project releases. Release 1 will address the Service Performance Management Capability to support Principle 1 and Principle 3 above and represents the scope of the Architecture Description, as specified in this case study. In addition Principles 4 to 7 above were to be implemented for all viewpoints of architecture development.

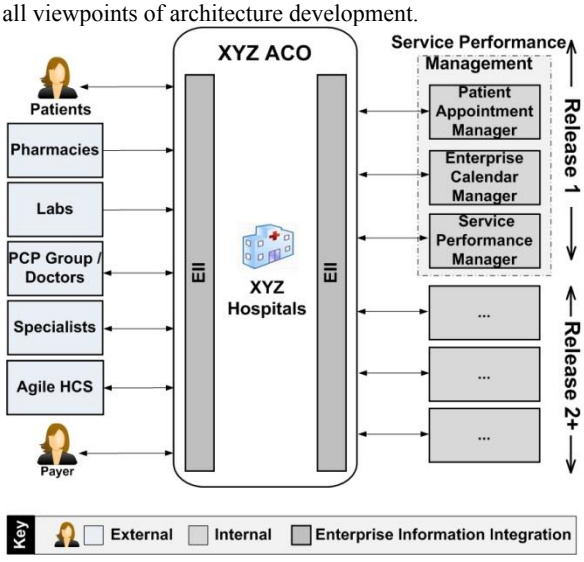

Figure 2. XYZ ACO Business Context Diagram

Figure 2 is the Business System Context Diagram for XYZ ACO for Release 1. In the diagram internal systems are on the right colored in gray, while external systems and

individuals (e.g. Patients and Payers) are shown on the left colored in light gray. XYZ ACO would serve as orchestrator between internal and external entities, with an Enterprise Information Integration (EII) component providing data integration capabilities both internally and externally. The EII component will be partially implemented in Release 1 to support Service Performance Management in the areas of Patient Appointment Management, Service Performance Management and Enterprise Calendar Management. Future releases will address principles of the business systems architecture viewpoint focused on the Centralized Payment Management using a unique member identification number. The application architecture to realize Service Performance Management capabilities should address concerns pertinent to assessing the primary care physician/ specialist functions and quality of service provided to patients treated at XYZ ACO hospitals. This includes reporting on their daily, weekly and monthly work schedules, medical procedures performed, and patients' review of health care services received during visits and/or treatment at XYZ ACO hospitals.

For Release 1 a Performance Analysis of the initiative was done in terms of Goals and Measures at three levels, namely the Organization Level (strategic), the Process Level (tactical) and Activity Level (operational), focusing on the Design and Implementation, and Management activities to achieve the stated Goals and Measures. Table 2 is a summary of this analysis, and facilitated the alignment of IT Strategic Planning with the enterprise strategy, particularly as it has bearing on the new XYZ ACO Health Care initiative. At the Activity Level the scope and planning for the EA Project are described in the Architecture Project Plan and the Statement of Architecture Work (developed as part of Team Assignment 1). The architecture approach followed by the project team is described in Section 3.

2.3 Teamwork

The team was formed based on architecture roles and interests of the five students in the class, and the architecture viewpoints assigned. The team was culturally diverse and all students but one were foreign born. All students were educated up to the undergraduate degree level outside the United States and all of them studied for their masters' degrees in the United States. Experience in the fields of architecture and application development varied among team members, with some expertise and skills in business analysis, information systems development, software engineering, and database modeling represented in the team. General guidelines were provided regarding expectations of teamwork as well as the goals and project requirements within the context of the project charter. Team members were assigned to particular viewpoints, with the course faculty member and the XYZ ACO project sponsor playing active roles in the project. On-ground team project tutorials were held by the faculty member during which potential views (of the viewpoints) were considered, the representation schemes and notation discussed and determined for the models that were being developed. Guidance was given to team members for each viewpoint entertained in the project in the form of design patterns, templates, and representative principles for developing models for each viewpoint. The concerns of the target organization were presented by the project sponsor, and further analyzed by the team. The project sponsor also supported the team when there was need for clarification on particular aspects of the business case. The assignment deliverables developed during the course are addressed in Section 3.4. Team members were required to collaborate with each other as they developed models for the views of the respective viewpoints assigned to them, making the teamwork a very real architecture experience. The team became aware of the importance of alignment and architecture governance for the XYZ ACO initiative within the context of the enterprise strategy. Ultimately the intent was to obtain seamless integration of the viewpoint architectures developed by each team member.

Factors influencing successful teamwork include following a defined teamwork process. This involves obtaining participation and involvement of all team members, and maintaining sound team management. In this project the faculty member served as team lead and assumed responsibility for managing the teamwork process. Quality individual efforts should be followed by the integration of the independent deliverables into a coherent result, here the EA Specification Document. A key success factor for working professionals when participating in this type of team project is regular communication among team members. Team members should be committed to the team by sharing a sense of purpose, working in the assigned roles as business and technology architects, and displaying mutual trust in each other.

2.4 Selection of the Architecture Approach

Extensive experience has been built over a number years on architecture approaches in the education context by the senior author. The students were exposed to a number of widely published architecture approaches (CEA, 2012; The Open Group, 2012; Cameron and Purao, 2010; Cameron, 2008; Zachman, 2007; Schekkerman, 2006; Steenkamp et al, 2004), and were well versed in the frameworks, methodologies, and tools that are used in the practice. Projects like the one reported here require an agile and lean approach which requires student teams to apply the theory of architecture development with rigor while also providing experience with interpreting the project charter, developing a project plan, performing analysis of the organization, and understanding the process and project requirements for the EA project. There was a tight time constraint to meet the project charter, and an agile and lean architecture approach that has been used in a number of architecture projects over several years was adopted in this project.

2.5 Architecture Viewpoints Addressed

The architecture viewpoints of interest for the XYZ ACO health care initiative and the EA team project were considered in allocating teamwork responsibilities. With the scope of the project charter in mind, viewpoints entertained were the Information, Business System, Data, Application and Enterprise Security Viewpoints; the overarching Enterprise Viewpoint was addressed by faculty and the project sponsor.

Level	Goals and Measures	Design and Implementation	Management
Organization (Strategic)	Goals defined and Measures determined Goals are: Quality systems, Affordable systems and care, Accountability, Transparency, Ease-of-Use, High Security Measures are: • Quality: Improved Patient Service (SPR) – # favorable patient reviews per doctor/ specialist per month • Affordability: Ratio of Services/ Cost (Financial); # patients serviced per month; # medical procedures performed per month • Accountability: Compliance with AC Act • Transparency: Data/ Information available to all through authorizations • Ease-of-Use: User satisfaction • Security: # security lapses	Develop XYZ ACO Enterprise Strategic Plan which: • Ensures that performance of the enterprise is attained in terms of the Goals and Measures • Enables business continuity • Supports existing XYZ ACO Systems • Complies with Principles/ Concerns for the EA viewpoint • Calls for the Design and Implementation of an integrated EA Dashboard which indicates measures and has drilldown capability • Authorizes the EA initiative	• Plan, monitor, review and control enterprise performance in accordance with the Enterprise Strategic Plan • Verify that Goals and Measures are communicated. • Review EA Project progress i.t.o. stated Goals and Measures. • Maintain Senior Management support for EA initiative • Review Tactical Planning • Review alignment of tactical strategy with enterprise strategy
Process (Tactical)	Goals for business processes for EA initiative are defined and measures determined Process Goals Princ. 1- Improve care quality and access to health care Princ. 2: Affordability - reduce the cost of health services Princ. 3: Provide Information transparency among participating stakeholders Princ. 4: System Design must promote reuse within and among XYZ hospital chain Princ. 5: Flexible balance in complexity, manageability and performance Princ. 7: High Security of information, business systems, data, application and infrastructure Process Measures are:*(Refined for IT Strategic Planning and Control)* • Quality: Improved Patient Service (SPR) – # favorable patient reviews per doctor/specialist per month • Affordability: Ratio of Services/ Cost (Financial); number of patients serviced per month; # medical procedures performed per month • Accountability: Compliance with AC Act • Reuse: Templates, rubrics XYZ ACO standards enforced • Transparency: Data/ Information available to all through authorizations • Ease-of-Use: User satisfaction • Security: number of security lapses	• Align process Goals and Measures with Organization Level goals • Perform XYZ ACO Tactical planning: IT Strategic Plan developed in several Releases; supports Enterprise Strategic Plan • Architecture initiative complies with Principles/ Concerns of EA for all viewpoints • Meta Architecture Analysis is done for enterprise viewpoints • Authorize EA Projects	• Plan, monitor, review and control the Tactical performance in accordance with Tactical Plan/ IT Strategic Plan • Verify that process Goals and Measures are communicated • Review EA Project Releases per Design and Implementation i.t.o. business process Goals and Measures for EA initiative • Verify that Strategy and IT Strategic Plan for EA initiative is well articulated and communicated to stakeholders • Maintain Senior Management support for the EA initiative • Maintain Stakeholder support for EA Project • Track alignment of IT Strategic Plan with Enterprise Strategic Plan
Activity (Operational)	Release 1 Goals Princ. 4: System Design must promote reuse within and among XYZ hospital chain Princ. 5: Flexible balance in complexity, manageability and performance Princ. 6: Components must maintain high cohesion and a low coupling Princ. 7: High Security of information, business systems, data, application and infrastructure Activity Measures: • Quality: Improved Quality of Patient Service (SPR) – satisfaction ratio (# favorable patient reviews per doctor/ specialist per month) • Transparency: Data/ Information available to all (# incidents of non-accessible data/ information) • Reuse: Templates, rubrics XYZ ACO standards enforced • Ease-of-Use: User satisfaction with user interfaces • Security: defined for all viewpoints; number of security lapses	• Align Goals & Measure with IT Strategic Plan • Develop EA Project Plan Release 1 • Define SAW document • Refine viewpoint principles • Perform Meta Architecture Analysis for viewpoints • Identify and select standards • Define views for each viewpoint and develop models (conceptual, logical, physical) • Maintain EA Repository and System Documentation • Implement EA Release 1 initiative	• Plan, monitor, review and control the EA Project performance in accordance with EA Project Plan • Goals & Measures for EA Project Release 1 are communicated • EA Project Goals and Measures are met • Track alignment of EA Project Plan with IT Strategic Plan

Table 2. XYZ ACO Performance Matrix (adopted from Harmon, 2007, pp.6)

3. ARCHITECTURE APPROACH

An architecture approach for developing the enterprise architecture specifications involves the architecture processes and steps of the methodology supporting the processes to be followed, and the tools to construct the models of the architecture. The selected architecture approach is systematic and has the features of agile and lean development as described in this section. This approach is characterized by five essential components, namely the architecture principles and concerns relevant for an EA initiative, the architecture meta-architecture framework, the architecture process model, the supporting architecture methodology, and the tool environment for developing the models for the EA architecture specification. These components are described in brief in the next sub-sections.

3.1 Meta-Architecture Framework

The complexity of systems and processes of medium to large enterprises requires that IT systems not be viewed in isolation, but that all relevant factors and concerns be taken into consideration when developing architecture models. The meta-architecture framework is based on the interpretation of ***architecture***, as the fundamental organization of a system embodied in its components, their relationships to each other, and to the environment, and the principles guiding the architecture design and evolution. The architecture design specifications are a blueprint of the policies, plans, processes, systems and stakeholders of the organization, and serve as a starting point for analysis, design, and decision making. The goal of rigorously documenting the EA is to provide insight in the organizational structures, processes, and technologies that make up the organization, allowing opportunities for improvements in efficiency and strategy alignment to be examined. A meta-architecture framework provides an analytical frame of reference to deal with the complexities when planning, developing and integrating the constituent architectures of the EA. It provides guidance by analyzing the enterprise assets in terms of viewpoints and constituent views when defining architecture models of a target enterprise system. This analytical schema enables architects to consider all relevant organizational matters, including concerns of stakeholders, principles underpinning decisions of policy makers and architects, roles of stakeholders, standards, and model notations when modeling the architecture specifications.

The analysis was performed by the project team of the XYZ ACO Group, structured into the Enterprise Information, Business Systems, Data, Application and Enterprise Security Viewpoints, and given in the Teaching Case Notes, Table 1. The meta-architecture framework schema is given in Table 3 below. In the project the analysis was done for each viewpoint of concern providing the data for each cell in the matrix.

3.1.1 Summary of Meta-Architecture Framework Attributes: The meta-architecture framework has a matrix representation scheme with attributes to be instantiated for the models of views of viewpoints of importance to stakeholders. The terminology used here is reviewed briefly.

A **Viewpoint** defines abstractions on the set of models representing the EA. It is a specification of the conventions for constructing and using the views that contain identity, state, and behavior of a model. The term **View** is used to refer to the expression of a system's architecture (strategic, tactical and operational) with respect to a particular viewpoint and may be of a particular **Type**, namely conceptual, logical or physical. A viewpoint may have one or more views that are expressed in terms of models. Viewpoint **Models** are the collection of models that are developed for the views of a viewpoint. A view is based on a pattern or template from which to develop individual models by establishing the purposes and audience for the view, and the techniques for its creation and analysis. This taxonomy may be used to manage the inherent complexities in architecture work. When modeling a view a particular language is used to describe the view as defined below. The **Architecture Phase** refers to the phase in the architecture process model when the model of a view is developed.

Other framework attributes are summarized next:

- ***Purpose*** pertains to the intent and use of architecture views, and to facilitate the expression and communication of the viewpoints thereby laying a foundation for quality through standardization of elements and practices for architecture descriptions. The purpose is determined by what a stakeholder wants to achieve. The purpose is categorized into the processes of *designing*, *deciding*, and *informing*. *Design* views support architects and designers in the design process from initial sketch to detailed design, and typically focus on a specific conceptual domain (e.g. application architecture, business process model) but can also be used to define the inter-dependencies between domain architectures; *Deciding* views assist managers in the process of decision making by offering insight into cross-domain architecture relations, typically through projections and intersections of underlying models (ex: cross-reference tables, landscape maps, lists, and reports); *Informing* views help to inform any stakeholder about the enterprise architecture, in order to achieve understanding, obtain commitment, and convince adversaries (e.g. illustrations, animations, flyers, etc).
- ***Stakeholder(s)*** refer to people who have key roles in, or concerns about, the EA such as for example users, developers, or managers. Stakeholders may be individuals, teams, or organizations interested in a view of an architecture initiative.
- ***Concerns and Principles*** embodied in a view. *Concerns* are the key interests important to the stakeholders of the target system, and determine the acceptability of a new architecture design for the stakeholders. Architecture *Principles* provide guidance for analysts, architects and designers when developing architecture models. (refer Section 3.2)

Model Portfolio for Each Viewpoint											
Model	View/ Type	Stage/ Phase	Purpose	Concern/ Principle	Stakeholder	Content	Layer	Aspect	Standard/ Best practice	Modeling Language	Tool
Data	*Data*	*Data*	*Data*	*Data*	*Data*	*Data*	*Data*	*Data*		*Data*	*Data*

Table 3. Schema of Meta-Architecture Framework

• ***Content*** refers to what is contained in a view, and is characterized by the three abstraction levels: *Detail*, *Coherence*, and *Overview*. *Detail* provides the necessary information at the various architecture layers to the interested stakeholders in the various domains (e.g. information, product, process, and organization domains at the business layer; data domain and application domain at the application layer; and technical infrastructure domain at the technology layer of the architecture). Detail can span the gamut from UML components and deployment diagrams to business process models. *Coherence* content extends the view to more than one layer in order to focus on architecture relationships (e.g. process-uses-system or application-uses-object). Typical stakeholders are operational managers responsible for a collection of IT services or business processes. *Overview* content represents multiple layers at a very high level (e.g. an executive overview) to be addressed by management and enterprise architects.

• ***Layer*** includes business, application, and technology layers (these layers correspond to the business, system, and technology levels in the Zachman framework).

• ***Aspect*** refers to the structure, behavior, or information (these aspects correspond to the network, function, and data aspects of the Zachman framework).

• ***Modeling language*** is the syntactical definition used when developing a model, and is formal, semi-formal, textual or graphic.

• ***Standard/ Best practice*** refers to the de facto or de jure standard or best practice adopted when developing a model.

• ***Tool*** refers to the automated capability used to develop the model, and which supports the modeling languages for the definition, development, generation, editing, and management of architecture views.

3.2 Concerns and Principles

Concerns and principles pertain to the EA initiative's functioning, development, and operation, including considerations such as performance, reliability, security, distribution, and extensibility. The principles should be stable, but flexible enough to accommodate changes in the IT environment. Table 4 shows the main concerns and principles for this team project, here completed for the overarching Enterprise Viewpoint using the TOGAF 9 template (The Open Group, 2012). Each principle is identified by name and number, a descriptive statement, the rationale and implications. Decisions drawn from the Enterprise Viewpoint may have greater long-term value than those made from any particular viewpoint. Table 2 in the Teaching Case Notes provides the principles for all the viewpoints considered by the project team that guided the architecture and design level development efforts for the XYZ ACO project.

OVERARCHING ENTERPRISE VIEWPOINT	
CONCERN/ PRINCIPLE	**DEFINITION**
Quality	**XYZ ACO Group Quality Care**
Statement	The Enterprise should provide excellence in care through its coordinated care services.
Rationale	Strategic Business Vision is to have an accountable health care organization providing coordinated excellence in health care services.
Implications	Health care services provided by all stakeholders must be of consistent quality throughout the enterprise; Requires that a systematic enterprise architecture be developed adhering to all the stated principles
Affordability	**Affordable Health Care Services**
Statement	Health Care Services should be affordable for the membership
Rationale	Strategic Business Vision
Implications	Costs should be contained by all stakeholders throughout the Group; sustainable health care spending; comply with Affordable Healthcare Act of the Centers for Medicare & MediCaid Services (CMS)
Accountability	**Accountable Health Care Services**
Statement	XYZ ACO aims to manage healthcare costs through accountability by all stakeholders
Rationale	Strategic Business Vision
Implications	All stakeholders must be accountable for their services and behavior and healthcare must be managed; confidentiality if patients must be maintained
Ease of Use	**Applications easy to use**
Statement	Software Systems and User Interfaces must be easy to use
Rationale	Complexity must be reduced to avoid mistakes
Implications	Flexibility and ease of use must be balanced in terms of complexity, manageability and performance
Transparency	**Information Transparency and Visibility**
Statement	Data and information must be transparent to stakeholders
Rationale	Data and information must be transparent (visible) to the users based on need to know and responsibility
Implications	Authorizations must be given and authentication performed on all classes of users of the systems

Table 4. Concerns/ Principles Governing the Enterprise Viewpoint

3.3 Architecture Process Model

Like other life cycle process models an architecture process model structures the architecture processes into interrelated life cycle stages to depict the tasks of architects and developers who will plan, manage, develop, evaluate and maintain the enterprise architecture. The Architecture Process Model in Figure 3 illustrates the stages of architecture development processes and the relationship between the enterprise strategy and IT strategy of XYZ ACO and was provided to the team as part of the architecture approach. It represents an iterative process to ensure the agile development of the EA specification that is efficient and adaptive to business needs. The focus in the project was on the Information/ Business Systems Architecture Stage and the Architecture Stage. The team project sponsor provided some input regarding the enterprise and IT strategies of XYX ACO to give context to the EA initiative. This agile process model, informed by the Agile Manifesto (Beck et al., 2013), was of particular value in the project since the time constraints of the project were finite. The four core values of agile process models and supporting methodologies are: 1. Stakeholders and their interactions have priority over processes and tools; 2. Working software, in projects of this kind the prototypes, are regarded as of more value than comprehensive documentation; 3. Customer collaboration, in this case the project sponsor, was of essential value; and 4. The project plan was used as a living document and updated as the project progressed. The main principles of Lean Development as described by Poppendieck (2007) were incorporated, including elimination of redundant work, focus on quality, continuous learning, mutual respect of stakeholders and team members, adherence to the project plan to deliver specific project deliverables, and always aiming to integrate the artifacts (of deliverables) into an integrated whole.

3.4 Architecture Methodology

Along with the architecture process model, the lean architecture methodology provided detailed steps and guidelines to be followed in the process model stages and phases, as well as specific deliverables for this team project. As mentioned a selection of the models developed in this project are given in the Teaching Case Notes supporting this paper.

The steps of the methodology are given in Table 5, along with the required artifacts to be developed and the main team assignments (TAs) resulting from executing the steps of the methodology. Each team member was responsible for models relating to the assigned viewpoint, and team members collaborated to develop artifacts of mutual interest.

3.5 Tool environment

The project team used the following tools to accomplish this project:

- Microsoft Project to create the project plan, define the schedule, the work-breakdown-structure, assign resources and monitor resource usage;
- Microsoft Visio to develop the use cases;
- OpenText ProVision Workbench for developing the architecture models;
- Microsoft Excel to create the budget estimation, and manage cost to budget allocations;
- Microsoft Word For project documentation;
- Blackboard/WIMBA and Skype for online meetings of the project team.

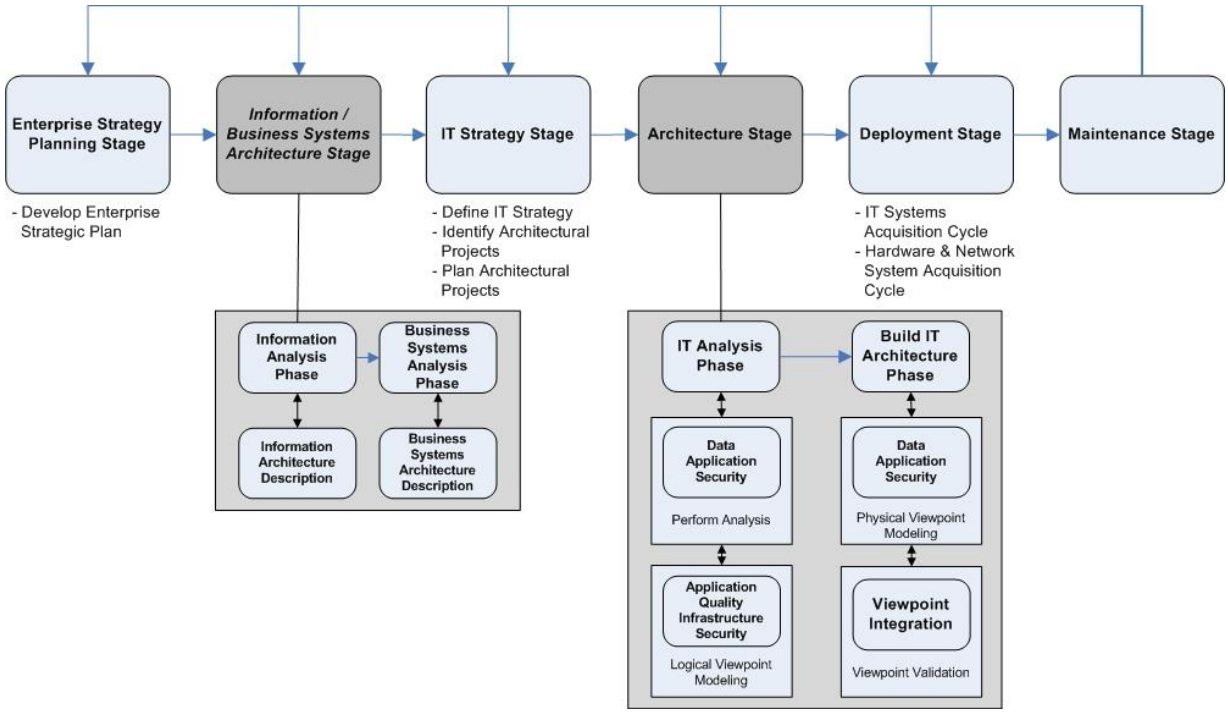

Figure 3. Enterprise Architecture Process Model

Architecture Stage/Phase	Steps	Deliverables
IT Architecture Stage Planning Phase	1. Review project charter 2. Review viewpoint guidelines 3. Adopt architecture framework 4. Prepare Architecture Project Plan 5. Determine Framework/review concerns/ principles within context of chosen architecture framework for viewpoint.	Architecture Project Plan - **TA1** Framework and Process Model Overarching and viewpoint concerns/ principles
Architecture Stage IT Analysis Phase	6. Perform functional analysis; analyze project requirements, interpret project charter; develop viewpoint definitions	Viewpoint definitions: Function tables
	7. Gather information requirements from team and project sponsors relevant to viewpoint	Viewpoint requirements: Use-cases and scenarios
	8. Choose representation schemes, modeling notations and CASE tool.	Representation schemes/ notions
	9. Adopt documentation method and template.	EAB documentation method and project folder format
	10. Adopt method for alignment with enterprise and IT strategies.	Performance Matrix and alignment method
	11. Model logical views and document using CASE tool.	System component diagram, UML sequence diagrams, UML class diagram using tools (Section 3.5)
	12. Develop Draft Architecture Description	Draft Architecture Specification **TA2**
Target Architecture Stage Build IT Architecture Phase	13. Determine draft architecture design/scope; model physical views and document using PVW	Assigned architecture
	14. Develop Service Level Agreement	Service Level Agreement
	15. Develop Disaster Recovery Plan	Disaster Recovery Plan
	16. Complete the Architecture Specification Document	Final Architecture Specification Document **TA3**

Table 5. Architecture Methodology

4. MODELS

This section summarizes the models developed by team members as home assignments. A selection of models developed by the team when following the architecture process model of Figure 3 for each viewpoint, is included in this paper as appropriate, and some others are provided in the Teaching Case Notes accompanying the paper. The models vary in level of detail and type, such as conceptual, logical and physical. A conceptual model is an abstract rendering of a view, whereas a logical model provides more generic static and behavioral data needed to implement the model in reality. A physical model includes decisions about software and hardware systems and related infrastructure of an implementation, and represents the intended reality. The analysis of the project charter and teamwork requirements for the architecture initiative enabled the team to fully populate the meta-architecture framework (refer Teaching Case Table 3. Schema of Meta-Architecture Framework), and a selection of these models, developed by the team in the architecture stages and phases, are indicated in the populated architecture framework in Teaching Case Notes, Table 1. To facilitate referencing in this Teaching Case and supporting Teaching Case Notes, Table 6 below provides the partial architecture framework showing the first three columns (of Teaching Case Notes, Table 1), i.e. the viewpoint, model portfolios and views/model types. Figures and tables in bold are actually shown in either the Teaching Case paper or the supporting Teaching Case Notes. As mentioned the viewpoints of interest in this team project were Enterprise, Information, Business System, Data, Application and Enterprise Security viewpoints. It must be noted that other viewpoints would also be needed but were not addressed due to team size and time constraints, and are by no means of lesser importance.

4.1 Enterprise Viewpoint Models

Enterprise Viewpoint models provide the context of the EA initiative, the strategies, concerns and principles of XYZ ACO. Table 6 lists the models developed by the team, included in this paper and in the supporting Teaching Case Notes: Teaching Case Notes Table 3 (1.1) XYZ ACO Business Strategy, and Teaching Case Notes Figure 2 (5.1) XYZ ACO Value Chains. The XYZ ACO Performance Matrix (Table 2) presented in this paper, summarizes the performance analysis of the EA initiative for XYZ ACO in terms of goals and measures at three levels, namely the Organization Level (strategic), the Process Level (tactical) and Activity Level (operational). The XYZ ACO business strategy is stated in the Teaching Case Study Notes, Table 3.

Viewpoint	Model portfolio	View/Model type
Enterprise	XYZ ACO Value Chains **Teaching Case Notes Figure 1**	Process Model/ Conceptual
	Statement of Arch. Work Template **Teaching Case Table 1**	SAW Template/ Logical
	Populated Architecture Framework **Teaching Case Notes Table 1**	Framework/ Conceptual
	XYZ ACO Performance Matrix **Teaching Case Table 2**	Strategic-Tactical-Operational/ Planning
	Business Strategy Table **Teaching Case Notes Table 3**	Strategy Statement
	XYZ ACO Principles & Concerns, **Teaching Case Table 4** Viewpoint Principles & Concerns **Teaching Case Notes Table 2**	Statement of Princ. & Concerns/ Planning
Information	Hierarchy of Information Needs **Teaching Case Notes Figure 3**	Inf. Req. Diagram/ Strategic-Tactical-Operational/ Planning
	Core Information Requirements **Teaching Case Notes Figure 4**	Information Req.Diagram / Logical
	Summary of Information Flows **Teaching Case Notes Figure 5**	Information Flow/ Logical
Business Systems	XYZ ACO Business Capability Map **Teaching Case Figure 1**	Bus. Taxonomy/ Conceptual
	XYZ ACO Business Context Diagram **Teaching Case Figure 2**	Business Context
	Patient Appointment Scheduling **Teaching Case Notes Figure 6**	Process model/ Conceptual/
	Service Performance Management **Teaching Case Notes Figure 7**	Process model/ Logical
Data	Partial CRUD Matrix **Teaching Case Notes Table 5**	Functional/ Logical
	Conceptual Data Model **Teaching Case Notes Figure 8**	Data model/ Conceptual
Application	Physician Performance Reporting System Use Case **Teaching Case Notes Figure 9**	Use case/ Conceptual
	Patient Appointment Manager System Use Case **Teaching Case Notes Figure 10**	Use case/ Conceptual
Security	Composite Enterprise Security Diagram **Teaching Case Notes Figure 11**	Enterprise security/ Conceptual
	High Level Security Model of XYZ ACO **Teaching Case Notes Figure 12**	Security model/ Conceptual
	Information Security Management **Teaching Case Notes Figure 13**	Strategic- Tactical- Operational/ Security

Table 6. Partial Architecture Framework

4.2 Information Viewpoint

This section contains the models for the Information Architecture viewpoint. The Information Architecture represents the information required by the processes and activities performed within the XYZ ACO. The architecture describes the interdependencies, connections and relationships of information entities. Teaching Case Notes Figure 3 gives the Hierarchy of Information Requirements of this initiative summarized into three categories, namely strategic, tactical, and operational information. The figure shows a systemic structure of information requirements for the entire enterprise, since effective information analysis should consider all levels of the business in order to obtain comprehensive information architecture for the enterprise as described by Perks & Beveridge (2003).

4.3 Business Systems Viewpoint

The business systems viewpoint comprises the business processes, systems, and other resources that are used to perform XYZ ACO's operational activities. Release 1 of the new EA addressed Service Performance Management capability and Patient Appointment Scheduling, defining the scope of the project. The business systems viewpoint was guided by two core principles namely Quality and Accountability. Adherence to the other principles was required for all viewpoints of architecture specifications.

Models for this viewpoint include the XYZ ACO Business Capability Map in Figure 1, which highlights some key capabilities to be leveraged in realizing the stated enterprise strategy. Other models for this viewpoint include the XYZ ACO Business Context Diagram in Figure 2, Patient Appointment Manager System (Teaching Case Notes, Figure 5.9) and Physician Performance Reporting System (Teaching Case Notes, Figure 5.10).

4.4 Data Viewpoint

Data is the most valuable asset of an organization, and may be aggregated, analyzed, and acted upon to deliver meaningful information. XYZ ACO has recognized the need for accurate and reliable data for accountable care and the key principles of share ability, accessibility, and security. A comprehensive data analysis of this viewpoint was done to identify the XYZ ACO organizations that create, read, update, and delete data from each of the data entities, and resulted in the partial CRUD Matrix (Teaching Case Notes, Table 5. The CRUD Matrix provides a list of data entities and the business systems that access the data based on the requirement, i.e. (C) create, (R) review, (U) update, and (D) delete. It also includes a Conceptual Data Model of XYZ ACO (Teaching Case Notes, Figure 8, containing the main classes along with their attributes and data types. The relationships among classes are governed by the share ability and accessibility principles.

4.5 Application Viewpoint

Models of relevance to Release 1 of the EA Initiative were developed by the team and include the Service Performance Reporting System which forms part of Service Performance Management, and the Patient Appointment Manager System. The application architecture to realize the Service Performance Management capability shown in Figure 1 addresses concerns pertinent to assessing PCPs/Specialists work and their quality of service provided to patients treated at XYZ hospital. This principally includes reporting on their daily, weekly and monthly work schedule, medical procedures performed, and patients' review of health care service received during visits and/or treatment at XYZ hospital.

4.6 Enterprise Security Viewpoint

The requirements of the XYZ ACO Enterprise Security Architecture is holistic and encompass all security-related concerns of the EA initiative, including physical, data, information, application, and infrastructure security. This means that the security architecture viewpoint is regarded as a composite viewpoint requiring models in all viewpoints. In addition, other security related concerns deal with:

- Corporate governance, including the security compliance to information security policy and procedures.
- Security management on the strategic, tactical and operational level.
- Legal, ethical and social concerns pertaining to information security.
- Human resources concerns relating to all people directly and indirectly, such as the security culture, security awareness and training.
- Security of physical facilities including all the resources needed to house and protect IT systems in the organization (e.g. physical access control and security doors).

Among the models developed for this viewpoint are Composite Enterprise Security Diagram (Teaching Case Notes, Figure 11), High Level Security Model (Teaching Case Notes, Figure 12) and Organizational Levels of Information Security Management (Teaching Case Notes, Figure 13).

5. DISCUSSION

A selection of artifacts developed and used in the team project is included in this Teaching Case paper. Some supporting models also developed by the project team are given in the Teaching Case Notes. Feedback on the course design and integration of a team project into the course has been positive. For their Course Reflection students reported that their exposure to theory and practice of enterprise architecture adequately prepared them for the course assignments. In particular the coverage of technology, representation schemes, notations, and tools available to model the behavior and structure of target architectures prepared them for the team assignments.

In the individual assignments, completed early in the course, students found it stimulating to analyze a business problem of their own choice and propose an IT enablement intuitive with EA focus, and that it enhanced their problem solving skills. Students' feedback regarding the team project component of the course included a number of points:

- the beneficial experience of learning-to-use while applying their theoretical knowledge to the XYZ ACO business case;
- team members' varying academic and experiential backgrounds were complementary, challenging them to collaborate efficiently in areas of individual competence, while also sharing and integrating the deliverables of their assigned tasks into the architecture design document;
- team members were equipped to work independently on their architecture viewpoint as assigned in project;
- collaboration among team members was a positive learning experience;
- the tools provided in the course to develop architecture models were very useful;
- collaboration was facilitated by the file exchange capability in BB helped team members to exchange files efficiently; color coding used to differentiate the team members' contributions was very helpful when multiple team members are working and modifying the same document;
- The team project provided an understanding of the different viewpoints of the EA. How these viewpoints interact, interrelate and complement each other is something that would have been hard to understand without this team project;
- It became clear what the value of IT enablement and the EA are to an enterprise;

Student feedback also raised some issues they experienced, such as:

- Different levels of performance of team members at times resulted in project delays, and reduced other team members' motivation and quality of the final outcome;
- Experimenting with a tool such as Google Docs could have been better
- It was hard to integrate artifacts into a consistent and coherent architecture design document; there were duplications and other redundancies, inconsistent terminology and naming of figures and tables, and similar issues;
- While peer reviewing of team members' artifacts to ensure quality control was time consuming, but at the same time afforded the opportunity to review and comment on each others' work;
- Some students felt the insufficient number of face-to-face meetings and that the virtual meeting technology, Wimba, was not as good as they needed;
- Some students would have preferred to have the team project start earlier in the term, so that there would be more time to integrate the multiple models, deliver quality deliverables, and develop a prototype of the target system;
- Team members needed more involvement of the project sponsor, and only later in the project understood the importance of reaching out for support.

From the faculty perspective this team project experience also demonstrated how a culturally diverse group of students, faculty and sponsor, representing six nationalities, can work effectively on a team project. The project emphasized the need for a sound foundation in IT systems, project management and supporting tools, and affirmed that specific prerequisite knowledge and experience are needed before allowing students to register for this type of course. It is just too time-consuming to tutor team members in areas of lacking knowledge and skills once the team project has started and also causes frustration among other well prepared team members. It was important to complement the on-ground class sessions with team tutorials during which specific issues and problems were discussed and addressed. Reviewing and grading team project deliverables represent a considerable investment of faculty's time, but the value of meaningful feedback to team members cannot be overstated. The challenges of managing a team project of this nature should not be under estimated. This project is another example of the benefits of having a course where students apply theoretical knowledge to a problem of practice, learning by doing, and the importance of virtual collaboration tools when collaborating in a hybrid mode, i.e. face-to-face in-class and virtual communication among team members.

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