Improving Health Analytic Process through Project, Communication and Knowledge Management

Research-in-Progress

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Abstract

A health analytics process model is necessary to carryout projects in a manageable and a repeatable way without having to rely on the individual skills and experiences. This study is one of the first steps in developing a comprehensive process model for health analytics. Literature suggests that successful IT systems require project management, communication management and knowledge management dimensions. This paper explores the inter-relationship among these supporting dimensions on health analytic project performance based on apriori determinability of project requirements as per their difficulty and clarity. The data were collected by one author working as an intern in a health analytic department of a hospital. The findings from this case study will be useful in developing and evaluating a well-defined process model as well as a theoretical model to represent health analytics process model usability.

Keywords: Health Analytics, process model, project management, communication, knowledge management

Introduction

Health Analytics (HA) is the “systematic use of data and related business insights developed through applied analytical disciplines (e.g. statistical, contextual, quantitative, predictive, cognitive, and other [including emerging] models) to drive fact-based decision making for planning, management, measurement and learning in the healthcare industry. Analytics may be descriptive, predictive or prescriptive” (Cortada et al. 2012). However, application of analytical disciplines (including HA) in a systematic manner has been mired by several factors. Firstly, data analysts prefer using an ad-hoc approach (implicitly planned in their minds) to HA in spite of the availability of several methodologies. Their focus is on improving the data models and algorithms rather than using a standard approach. Naur and Randell (1969) made similar observations in software engineering domain and they highlighted that such issues paved the way to software crisis in late 1960s. Moreover, existing models are not accepted by the data analysts as they are not designed as per their needs (Mohan and Ahlemann 2011). Secondly, the best practices in previous analytics projects are not well documented to be reused in future, prompting the analyst to depend on their skills and experience in carrying out the projects. Thirdly, the existing methodologies do not consider the holistic view of an analytic process and they aim merely for improvement of data modeling (technical) components of a process as in SEMMA (sample, explore, modify, model, assess) offered by SAS (Matignon 2007; SAS 2008) for example. These available process
models have failed to consider other related dimensions such as knowledge management, communication management and project management. Proper management of these dimensions is important for the success of the project outcomes avoiding over dependence on the experience of the data analysts.

Due to the uniqueness of medical data and the ever increasing value of the HA market, healthcare context was selected as the focal area of this study. In a study on uniqueness of medical data, Cios and Moore (2002) have identified (1) heterogeneity (Kwiatkowska et al. 2007), (2) ethical, legal and social issues, (3) statistical philosophy to address heterogeneity of data and social issues and (4) special status of medicine as the main factors that differentiate it from other data. In addition, it is projected that the HA market will be worth around $18.7 billion by 2020 from a worth of $5.8 billion in 2015 (MarketsandMarkets.com 2015).

Accordingly, for HA, a process model that allows to capture and reuse experience, that reduces over dependence on skills, results quality outcomes and that can be generalized to other contexts is required (Mariscal et al. 2010). A Unified Structured Analytical Model (USAM) with a well-defined methodological approach to analytics has been previously proposed by the authors (Ahangama and Poo 2015). USAM is an iterative and incremental life cycle model that is composed of methodological steps (data access, domain understanding, data understanding, conceptualization, data preparation, data modeling, validation and presentation) that can be pursued by the data analysts with appropriate flexibility to alter the sequence of steps based on the project variations. This paper aims at presenting the support dimensions for the USAM that are indispensable for the achievement of successful HA outcomes.

The research question is on ‘how to streamline organizational practices to achieve better performance’. Organizational practices are based on project management (PM), communication management (CM) and knowledge management (KM) dimensions. These underlying three dimensions supported by theory are used to explore and shed light on improvement of operational performance. This consists of a framework on how to improve HA performance in small-centralized analytics teams (one department handling HA projects of the entire hospital) using a qualitative study. The case research could be used to design and evaluate the utility of the model (as per the Design Science Research approach) and to revise the process model. By one author working as an intern in a recognized hospital with a HA department, we were able to understand their successful approaches to HA projects by being involved with their activities and participating in meetings as a member of the analytics team working on their projects as well as an observer.

The findings of this study will have several significant contributions. First, this support framework may be used as a reference model to determine the course of the analytics process. This will be a guide for the novice users working in HA departments. Even though the study was carried out in a HA context, it will be a generalized model applicable to other contexts as well. Second, the differentiation of the supporting framework based on the project type allows simplified application of HA with ease. Finally, the case research approach used to design and develop the supporting framework too will be a contribution of this study.

Theoretical Background

New product development in Information Systems plays four roles related to IT (Nambisan 2003). They are process management, project management (PM), communication management (CM) and knowledge management (KM). A similar approach was used by the authors of this study to design the USAM based on their prior experience. Even several software engineering and data mining methodologies have considered these dimensions although they are not specified explicitly. For example, CRISP-DM (Chapman et al. 2000) model gives some indications on PM at the initiation of the project. Chan and Thong (2009), mention the importance of KM (in creation, retention and transfer of knowledge) in developing a software methodology. The first dimension is the process management, dealing with the overall structure of the HA model. This includes input, outputs and activities in each phase of the model. In addition to process management, it is important to use PM, CM and KM (known as supporting dimensions) properly for the successful application of HA in real context.

Project management deals with the management and coordination of the activities performed in each stage of the process. In dealing with unknown project outcomes with ambiguity in project direction, there should be a methodology like agile to guide the project in the right direction. In Agile concept there are
four main attributes that are considered, namely, evolutionary approach, story driven approach, continuous collaboration and testing agile projects (Collier 2011). This is especially useful in long-term projects where the problem is not clearly specified at the beginning of the project. Agility is useful in responding to changes in a timely and effective way (Highsmith 2009).

Communication management is the second supporting dimension. Gartner has reported that, around 70% to 80% of corporate business intelligence projects fail due to poor communication (Goodwin 2011). This indicates the importance of communication for the success of an analytic project. This is especially, useful in healthcare context, due to the unfamiliarity of the analyst with health domain. In contrast to traditional (sequential) data mining methods where the communication with the users tend to be merely at the beginning of the project to get their requirements with very limited interaction like status update during data modelling stage, in agile approach, continuous collaboration will be promoted throughout the project (Collier 2011). Thus, agile approach allows effective communication with the stakeholders to provide necessary feedback (e.g. significant but meaningless findings could be detected and should be dropped from further consideration) and to realize new ideas and directions to explore the data.

Here, Media Synchronicity Theory (MST) (Dennis et al. 2008) is used to ask the right question, present the results and to maintain the right mode of communication between individuals working together to accomplish meaningful findings from HA. Two communication processes in MST are conveyance and convergence. Dennis et al. (2008) defined conveyance as the “transmission of a diversity of new information-as much new, relevant information as needed-to enable the receiver to create and revise a mental model of the situation” (p. 80). A variety of information is exchanged at this stage and extensive information processing is required. Dennis et al. (2008) have further described conveyance as “the discussion of the pre-processed information about each individual's interpretation of the situation, not the raw information itself” (p. 80). At this stage a mutual understanding will be reached among the individuals and less information processing will be required. In accordance with MST, while media of low synchronicity is used to carry out conveyance tasks, media of high synchronicity is used in carrying out convergence tasks.

Knowledge management is the final supporting dimension. HA projects exhaustively use knowledge, requiring effective KM to handle complex user requirements and stakeholders to a HA project from various backgrounds. Organisations need knowledge about domain, usage of different tools and techniques, local policies and practices (Lindvall and Rus 2002) and to reuse and retain captured knowledge within the project team and to share them among the team members (Chan and Thong 2009). Project knowledge is comprised of domain information, problem information and problem solving information (Byström and Järvelin 1995). Argote et al. (2003)’s organizational KM framework was used to study the knowledge outcomes: creation, retention and sharing and ways to improve individual’s ability, motivation and opportunity to achieve knowledge outcomes. Their KM framework is based on the KM outcomes and properties of the KM context. KM properties refer to characteristics of the knowledge users known as units (individuals and groups) and its relationship with knowledge. Through this study, individual’s motivation and opportunity to contribute will be improved while developing their ability to share and seek knowledge as specified by Chan and Thong (2009).

It is stated in literature (Pich et al. 2002) that ambiguity and complexity are the key factors leading to various approaches to project management. A similar line could be used in HA projects as well rather than using a single process model. Moreover, as stated by Byström and Järvelin (1995), apriori determinability of uncertainty about the requirements and task outcomes could be used as a basis for categorization of information processing tasks. Tiamiyu (1992) proposed another one dimensional task categorization based on complexity.

**Methodology**

Design Science Research approach (Hevner et al. 2004; Pries-Heje and Baskerville 2008) is applied in this study to describe the problem to be solved and to design the model using the related theoretical principles. This ‘exaptation’ study (Gregor and Hevner 2013) extends the known solutions in software engineering to the HA as well as to data mining contexts. At this stage, the aim was to get an actual understanding of the work carried out in a Hospital’s HA department.
Research Setting

The study was carried out in the HA department of Hospital Y, which is a government hospital in Singapore with more than 500 beds. They have a HA team working on different projects with several interns assisting in those projects at a given time. One of the authors worked as an intern for 4 months in the Hospital Y getting involved with their activities and occasionally participating as an observer. The staff members in the HA department were aware that the case was utilized for a research study in developing a HA process model. The specific hospital was selected for the study considering the management’s willingness to explore the use of a standardized process model for health analytic projects, their interest in research work and the proactive role taken by the hospital to encourage the use of health analytics in their day to day operations. Importantly, the business intelligence maturity level (Eckerson 2004) of Hospital Y’s HA department can be considered as at ‘Focused’ level (level 3) as there is a successful focus on the specific institute needs and funding available as grants on a project basis. Moreover, the management is interested in HA and that interest is created and enhanced among other employees too through internal workshops and presentations. Since we are aiming to develop a holistic process model considering the healthcare context, it is important to explore the model in the same context with the assistance of the practitioners. The Hospital Y will examine the proviso only for factual accuracy and the authors of this paper are free to express their own observations, opinions and postulations.

There are many projects running simultaneously in HA department of Hospital Y. Most of the HA projects are focussed on operational activities of the hospital to support their daily activities (e.g. forecasting patient flow to Accident and Emergency (A&E) department, patient discharges, etc.). Other than that HA department had undertaken several clinical based projects (e.g. risk stratification of patients) with necessary bio-medical validations. In addition, programmes related to population health too are carried out there.

The staff-members are guided by a team head widely recognised in the industry with indispensable experience in HA as well as in management. The head provides the necessary guidance and resources to the team to do projects effectively. These relatively young staff-members demonstrate familiarity from versatile backgrounds and are keen to learn numerous health domains while participating in multiple HA projects at a given time. Whenever, the staff members become unsure of the direction to proceed, they consult other senior members who had worked in similar projects and they depend on the Head of HA department too for guidance.

Research Process

As per the design science research approach, it is important to understand the ‘environment’ clearly and determine the challenges faced by the HA practitioners, and build the artefact relevant to the ‘business needs’. Case research approach was used to gather requirements and evaluate the model as an internal employee of the Hospital Y. To evaluate the model, iterative (use feedbacks to revise the process model) participatory case based approach based on the design criteria mentioned later in this paper will be used. The advantage of this study, is that in working as an intern in a HA department of a hospital, the authors were able to gain access to staff members, other stakeholders and the organization processes (Arnott 2006) and obtain a deep understanding of their issues and their relevance.

As an intern, a meta-diary was kept to record the daily activities performed and observed in the HA department to reflect the operational activities. The stakeholders were interviewed to gather the necessary information. The mirroring technique proposed by Myers and Newman (2007) where subsequent questions and comments based (mirrored) on the interviewee’s earlier responses was used to draw the interviewee’s opinions and under standings in their own language. First, the staff members were requested to explain their daily work activities to be followed by their experiences, practices and later their view of developing a process model. The interviews were carried out as formal opened question interviews mostly lasting for about 30 minutes each and with a few exceeding more than an hour. The interviews were open ended while maintaining the freedom and control using non-leading and non-passive questions. In addition, some information on this was gathered through daily informal discussions held during work and lunch breaks. Later on, the model will be presented to the members of HA department for feedback and the model will be further revised based on their comments. The interviews were transcribed for the data analysis. The data from each narrative (personal and interviews) was
organised and coded based on the three supporting dimensions determined previously. Later, the narratives were compared against the literature to synthesize and amend the model

**Design Criteria**

The projects can be separated according to difficulty (simple and complex) and clarity (clear and ambiguous) based on the apriori determinability of the requirements. This classification is according to the analyst’s point of view on the uncertainty of the task outcomes and information requirements (Byström and Järvelin 1995). Through this study, variations of projects were identified based on PM, CM and KM as shown in a grid in Figure 1. Other than that, the projects could vary based on the profile of the project and the urgency. For example, projects requested by the CEO (high profile project), will be considered as of high priority prompting regular meetings. If the project is urgent (mostly a simple task that can be done in a short time), then it would be generally sequential (request -> response) or with a very few iterations.

<table>
<thead>
<tr>
<th>Clarity</th>
<th><strong>Simple</strong></th>
<th><strong>Difficulty</strong></th>
<th><strong>Complex</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td>PM – No or less iterative with fewer revisions</td>
<td>PM – Iterative with revisions</td>
<td>CM – Frequent and less use of rich media</td>
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<tr>
<td></td>
<td>CM – Less frequent and less use of rich media</td>
<td>KM – More documentation on the analytic process and the model</td>
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<td>KM – Less documentation</td>
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<tr>
<td>Ambiguous</td>
<td>PM – Iterative with revisions</td>
<td>PM – Iterative with many revisions</td>
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<td></td>
<td>CM – High frequent and use rich media</td>
<td>CM – High frequent and use rich media</td>
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<td></td>
<td>KM – More documentation on requirements</td>
<td>KM – More documentation on requirements, analytic process and model</td>
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Figure 1. Project Types

In this study, only complex and ambiguous projects (*Project A*) and simple and clear projects (*Project B*) will be considered as the other two will be variations of them. The case organisation (*Hospital Y*) have useful and efficient practices to carry out their HA projects.

**Satisfying Design Criteria in General**

To achieve successful HA project outcomes, following practices are explored and the specific variations based on project difficulty and clarity will be specified later on. Due to the overlap between knowledge transfer and communication, knowledge management focuses on the overall department perspective (not only at project level). The main focus will be on the knowledge creation and retention. Communication includes information and knowledge transfer and the facilitating media.

**Project management**

- **Self-organizing teams** - The data analysts take initiative to perform the project and whenever, there is an issue with the shared understanding, they communicate with the client through emails rather than waiting for the project manager or department head. Also, the management depends on the data analysts to detect signs of trouble in their projects and inform early to take necessary actions.

- **Top management support** – The project manager can be considered as a facilitator, where s/he will be focussed on removing the barriers to do the project and management of the team.

- **Stakeholder coordination** – A project team includes planners (facilitators and project champions who may not be directly involved in the analytic process), doers (data analyst, ground staff of the requirement providing department) and consumers (use directly or indirectly the outputs generated by the doers) (Collier 2011).

- **Pseudo structure** - The individuals in the HA team establish relationships and develop a shared understanding. As such the requirement providers who worked in previous HA projects will usually work with the same analyst. This enables analysts to specialize in a particular domain area in HA, making it easy to understand the problem and the model as they have prior understanding on the
domain, data, and user expectations. Moreover, shared understanding creates lesser requirement for face-to-face discussions.

- Simultaneous project handling by each analyst - This is useful in dealing with unforeseen interruptions in projects. In other contexts focusing on one project at a time is encouraged to avoid prospective memory failure. In Hospital Y, this improves the productivity of the team. However, it is important to schedule projects in a way that the deadlines of concurrent projects do not fall in the same period. Therefore, prioritization of these multiple projects is important.

- Termination of projects - There are so many possibilities that should be looked into for continuous improvement of the results making it an unending process. However, with proper project planning and due consideration to the main focus of the group working on the HA project, it is important to decide on the appropriate time and conditions under which the project can be terminated. An analyst would be interested in improving the accuracy of the results. In addition, users should be confident that the model meets their requirements.

Communication

- Face-to-face communication - There are regular face-to-face discussions with the stakeholders to understand the problem from different user perspectives and to review the process (conveyance of project information to convergence). According to MST’s communication capabilities, this provides an immediate feedback and the symbol variety is higher as the gestures and voice tones are cues to realize the reception to the message. Furthermore, face-to-face meetings create a strong social presence allowing them to collaborate effectively and easily with a sense of togetherness. In addition, meetings create soft deadlines making it easier to plan. It is noted that the stakeholder discussions are more structured and more focussed as an agenda is prepared prior to the meeting. In a negative note, the meetings may sometimes extend the project completion date. When dealing with busy senior management and clinicians, finding a common time will be hard leading to project delays. As too many face-to-face meetings can cause project delays, sometimes it is advisable to use other asynchronous media for transmission of information.

- Presentations - They are useful to indicate the progress of the work and allow immediate feedback from the participants. Visual cues used in the slides and the tone of the presenter can be used to highlight important issues (symbol variety). Furthermore, it is observed that presentation slides (more formal and structured) are used as a substitute for a document repository too.

- Emails - As per literature and as per Hospital Y, emails (less rich media) are used for tasks with low complexity and high certainty. Emails are useful for task assignment and status reporting. Also, the meeting minutes are emailed to pass the details of the contents discussed and agreements made. Emails are used as a formal mode of communication and used as a document repository (folders with proper labelling) too. It is observed that some of the emails sent (queries or results) are not responded immediately by the receiving party due to very busy schedules of the partners (as for them HA is secondary when compared to providing patient care). Thus, the promptness of the feedback is low in emails. Emails allow parallelism as one can perform other projects or tasks while waiting for a reply. Moreover, the ability to rehearse is high as the sender can rethink and rephrase the message before sending. In addition, communication mode could vary based on the individual preference where as some clients may prefer face-to-face communication over emails and vice versa.

Knowledge Management

According to Argote et al. (2003)’s KM framework, KM can be successfully carried out by improving ability, motivation and opportunity. It is observed in Hospital Y, that most of the projects are performed in collaboration with many departments. For example, to carry out a project in the Department of Pharmacy, it may be required to have domain expertise and workflows of other departments like clinics and A&E too. Thus, sometimes analysts are purposefully rotated to increase the breadth of domain knowledge and this will enable newly recruited analysts to find where they are more comfortable with their expertise. Moreover, individual team member’s capability is improved through training and prior experience. Presentation slides and codes/scripts of previous projects and text books on analytics provide guidelines to users on best approaches to process and model data. The observations made on other senior analysts’ approach to data analytics are important to learn and adopt their best practices. Documenting the requirement gathering approaches, conversion of them to project goals and tools and techniques used
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as well as the organisation regulations to follow will be essential for KM. However, it depends on the effort an individual prepared to put forth and their perceived benefit.

Team co-location (Ambler 2009) where members are in close proximity is a possible option for knowledge sharing. In the HA department of Hospital Y, team members sit next to and facing each other (in an open space room). Discussing projects while having lunch together and sharing interesting facts is also means they use for informal networking. Moreover, working in pairs also creates an opportunity to learn from others and reduce risks of one analyst holding the domain knowledge related to a particular area or a project solely.

Other than the project and team level knowledge transfer, organisation wide knowledge transfer is observed in Hospital Y where talks are held to share experiences with other employees after attending conferences and book reviews. Also, senior management presentations on ‘vision alignment’ and guest speeches and admin meetings on quality improvement are held to improve shared understanding among employees.

The following factors relevant to the uniqueness of medical data (Cios and Moore 2002) will be considered in this study under the supporting dimensions.

- Heterogeneity of medical data – As a solution for the non-standard representation of medical data, standards such as SNOMED, ICD 10 can be introduced to represent medical data (Bellazzi and Zupan 2008). Specially, electronic medical records are represented using these standards. Even the medical data extracted from numerous other sources like case notes and images needs to be codified using these standards. Thus, the ambiguity existing in medical data sources could be avoided.

Considering the difference in training, knowledge and approaches existing among the medical professionals and computer scientists, heterogeneity of data sources is a barrier to work across these professions (Schmidt et al. 2008). It is necessary to gain domain knowledge for data understanding and model results understanding and clarification by continuous collaboration and consultation with domain experts. Experts from both domains (physicians and data analysts) need to inspect the data set and clarify the content. Thus, the communication management and knowledge management are important.

- Ethical, legal and social issues – De-identification and anonymization of patient data is done using the HIPAA (Health Insurance Portability and Accountability Act) standards in USA. Usually the access to the dataset will be authorized only for a specific time period based on the data analyst’s requests. Gaining prior approval from the relevant internal review board for access to the data before commencement of a major project is very important.

- Statistical philosophy - There will be a high volume of attributes in a medical dataset even though numbers of instances are less (Bellazzi and Zupan 2008). Thus, it is important to consider the feature selection strategies. All the attributes should be maintained in the dataset and only a group of attributes will be filtered, depending on the type of analytics to be performed. Then the model should be conceptualized using the selected attributes as the use of all the attributes in data analytics is not advisable and not possible (Bellazzi and Zupan 2008).

Quality of medical data is inferior compared to other datasets. There will be many missing and incomplete data. Thus, data pre-processing is an important component in handling medical data. There may be certain redundant, insignificant and inconsistent data instances and attributes (Cios and Moore 2002). To avoid such data objects, it is important to get expert advice before the removal or correction of them.

The selection of the data modeling technique should depend on the comprehensibility and the ability to explain. ‘Black box’ like methods (e.g. neural networks) is not transparent to data analysts and the users. Also, rather than using accuracy to evaluate the models, specificity and sensitivity are important measures to be used in medical context (Cios and Moore 2002).

- Considering the special status of medicine, it is important to use a standardized approach to perform analytics. As the decisions made through data modeling could lead to life or death situations, the data analysts cannot afford to miss certain components in the analytic process leading to incorrect results. Thus, it is essential to consider the three supporting dimensions in data modeling in the healthcare domain.
Satisfying Design Criteria in Project A

Project A’s requirements are complex and ambiguous. For example, a requirement in developing a productivity matrix for hospital staff is complex and ambiguous. It is ambiguous, as the expectations are not clearly defined (measure productivity of whom, on what basis/perspective, used for what, etc.). Also, it is complex as one needs to consider different levels and do background study, as it is not purely data driven. As such, the project could take a longer period to complete.

Considering the uncertainty and changes made to the problem statements in the long term projects as the project progress, envision-explore (rather than request-response) cycle in project management can be observed. This is in accordance with the APM framework proposed by Highsmith (2009). Envision is understanding what is to be done and how it is to be done (Collier 2011). Explore stage focuses on starting the HA with a simple iteration, reviewing with users and exploring possibilities of expanding the project. This is an iterative planning process with review of project scope. Thus, collaboration with stakeholders is an important aspect.

It is important to have both conveyance (to make correct conclusions about the problem) and convergence (to move forward in the project) due to nature of the projects. As the stakeholders are from different backgrounds using different terminology and there is ambiguity in the requirements richer media formats are appropriate for both processes. Face-to-face communication from requirement elicitation till the presentation of the results is important (in all stages). The communication will be less regular with the senior management compared to the middle managers and the junior staff (ground level staff). Senior management as planners will be more involved at the beginning of the project and there will be less involvement during the analytic process. Middle managers will be more involved throughout the project and will aid in getting the data and other resources. Ground level staff will be actively involved in providing the necessary aid in understanding the domain and data.

With the complexity of the project, the knowledge management should be available from requirement gathering stage till the end of the project. The created knowledge should be stored for reuse in future projects. This allows to complete, complex and ambiguous projects with similar requirements or background in less time by learning from the steps that are followed in previous successful projects. The requirements, users (and their expectations), situational assessments (feasibility), policies and regulations to adhere to and approval process, types of data used (with reasons for their usage), data processing steps and data modeling approaches can be noted. Moreover, it is important to include the interpretations of the results generated after data modeling as well as how the results are deployed or used by the users.

Satisfying Design Criteria in Project B

Simple projects with clearly defined requirements are considered here. As an example, a descriptive analytic project or forecasting patient flow to A&E based on triage can be considered. Most of these projects can be performed with less iteration. That is, with fewer revisions. It could be observed that some projects are performed in a sequential manner where a response is given as a request. Usually, sequential projects (no iterations) are very short duration projects lasting few hours to 2, 3 days. Thus, scheduling of milestones and meetings are not structured as in other complex projects. Communication would be available in all stages of the project. The selection of the communication process depends on the stage of the analytic process other than the type of the work. In project B, for conveyance of the domain knowledge and the requirements at the beginning, project team members have a face-to-face communication. During these meetings, analysts and project sponsors will come to a shared understanding of the requirements. Since there is low uncertainty and complexity, the convergence can be performed using less rich media like emails. The frequency of the meetings will be less compared to project A. Furthermore, during the data understanding, data processing and modeling phases, most of the communication will be maintained through emails with occasional meetings. At the end, results may be emailed to users. If more clarification is required then there will be a face-to-face meeting.

In project B, there will be less generation of knowledge compared to project A. Since the project is simple and clear, another analyst will easily understand the requirement for future projects too. However, as noted in Hospital Y, most of the content is documented as email, or in programming code and presentation slides. In documentation it is important to maintain the versions of data used as well as the
actions performed to generate the results in a shared folder even though it is not detailed as in project B. For example, requester names, analyst’s names, results and interpretations are important.

**Conclusion**

In working as an intern in a Hospital carrying out HA projects successfully, the authors were able to gain insight into the actual HA process of a small centralised team especially considering the uniqueness of the medical data. We observed the variation of the projects based on the complexity and clarity of the project requirements and how changes to the model should be proposed based on the project type relevant to each dimension (PM, CM and KM). Furthermore, their feedback was also useful in fine tuning the model and in coming up with the complete model.

As future work it is important to fine tune the USAM by including these supporting dimensions specific to the context and study the utility of the model as well as develop a theoretical model as per the guidelines proposed by Gregor and Hevner (2013). Utility of the model will be evaluated using a participatory case research based approach where the model will be designed with continuous dialogue with the HA practitioners as an iterative process. We expect to present this as a research in progress paper to obtain comments from conference participants for improvement and for theorizing this case research based study in order to achieve the expected contributions from the study.

**References**


