Requirements Engineering for the Uganda Police Force Crime Records Management System

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Abstract—**This paper presents the requirements engineering process for the Uganda Police Force Crime Records Management System. The system was envisioned to substantially improve the performance of the crime records management function of the Uganda Police Force through strengthening the pertinent processes. The requirements engineering process involved definition of the system context and goals, requirements elicitation, analysis and specification. The process was championed by the ARMS Project, Makerere University. Following the successful requirements engineering process, the ARMS Project together with the Uganda Police Force embarked on a two year project to design, construct and deploy the envisioned Crime Records Management System at selected police sites in Uganda. The key challenges faced during the requirements engineering process, such as changes in the composition of the Uganda Police Force project team, requirements traceability, and low representation of business process owners, are also presented.**

Index Terms—**Requirements Engineering, Crime Records Management, Workflow Analysis, Prototyping, System Goals.**

I. INTRODUCTION

The need for good record-keeping and information-sharing practices has taken on added significance in today's global environment [1]. This is especially true for law enforcement agencies and other security organs like the Uganda Police Force. Law enforcement officers deal with various challenges regarding the management of information during an investigation [2]. Implementation of an electronic crime records management system can improve operational efficiency and provide system support for decision-making.

In April 2010 the Uganda Police Force embarked on the process of acquiring a Crime Records Management System. The system was envisioned to substantially improve the performance of the crime records management function of the Uganda Police Force through strengthening the pertinent processes. The system was expected to increase the demand for and use of evidence-based reports and information for management analysis and decision-making at the appropriate levels within the Uganda Police Force. The institutionalization of the system was expected to provide greater autonomy, enhanced accountability, strengthened governance and management, and introduce data-based measurable performance management for the Uganda Police Force Crime Intelligence and Investigations Directorate.

The ARMS Project, Makerere University was engaged, through a standing Memorandum of Understanding, to advise the Uganda Police Force on the necessary steps to secure a beneficial and relevant Crime Records Management System. The ARMS Project is a research and development entity at the College of Engineering, Design, Art and Technology, Makerere University, focusing on web and mobile applications for e-Governance, e-Health and e-Commerce. The Uganda Police Force together with the ARMS Project engaged in a requirements engineering process to establish clear and feasible requirements for the envisioned Crime Records Management System. The requirements engineering process was expected to inform the design, implementation and operation phases of the project. It is important to note that a decision had been taken earlier on by the Uganda Police Force to develop the desired Crime Records Management System from scratch considering that such security critical systems are not readily available off-the-shelf and the unique business processes make custom development the most plausible option. The requirements engineering process was guided by the need to establish a basis for solution validation as well as providing input into the design and implementation phases of the project. At the time of writing this paper, the developed Crime Records Management System had been deployed at all police division headquarters in Kampala Metropolitan Police and other specialized units such as the Case Backlog Unit and Special Investigations Unit.

This paper describes the requirements engineering process for the Uganda Police Force Crime Records Management System. The paper is structured as follows: Section II discusses the definition of system goals; Section III presents the elicitation process and techniques used; Section IV discusses how the requirements were analyzed; Section V details the specification process and standards used; and Section VI discusses the challenges faced during this requirements engineering exercise.

II. Definition of System Goals

The definition of goals for the Crime Records Management System was informed by the need to institutionalize an electronic system to support the crime records management function of the Uganda Police Force Crime Intelligence and Investigations Directorate. At the time, it was noted that the manual practice used was bound by several limitations. Notable amongst these were:

- limited capacity for effective tracking of cases resulting into low detection and conviction rates, high case backlog, and protracted administration of justice;
- deficiencies in crime intelligence and investigations due to lack of a searchable crime database for cross referencing;
- possible irregular and unauthorized manipulation of crime records, for example, evidence tampering; and
- lack of system support for retrospective reporting to enhance police operations and crime profiling.

The above limitations, coupled with consultations with key operations staff involved with the crime records management business processes, informed the definition of the following system goals:

- supporting registration of complaints and station operations, such as officers reporting for duty and checking out for assignment;
- electronic case file management, including assigning investigating officers and logging evidence, witnesses, suspects, victims and other key case attributes;
- supporting electronic profiling of crime and criminals;
- retrospective crime reporting based on multiple dimensions, such as time, location, crime category, special interest groups, age and gender amongst others;
- maintenance of key system libraries, such as police administrative units, local government administrative units, police officers, judges, state prosecutors, prisons and crime categories;
- supporting internal communication with an embedded messaging service and virtual notice board;
- logging and tracking user activities based on CRUD (Create, Read, Update and Delete).

The consultations pertinent to the definition of system goals involved a diverse range of stakeholders. These included the Inspector General of Police, a Team of Detectives from the Criminal Intelligence and Investigations Directorate, a Team of Uganda Police ICT Officers and Systems Analysts from the ARMS Project, Makerere University. The involvement of the Uganda Police Force top management, key crime records management operational staff, as well as information systems expertise from the ARMS Project, provided the necessary ingredients for a meaningful definition of systems goals exercise.

Figure 1 is an illustration of the mapping of defined system goals to the Uganda Police Force crime records management roles. The system goals are categorized into three, based on whether they are pertinent to crime records management transaction processing, management information and decision support, or systems administration.

Case File Management typically occurs at a Police Station and the stakeholders involved include the Station Diary Constable (who registers complaints and sends them to the appropriate Officer in Charge), the Officer in Charge (who assigns investigating officers and oversees the investigations) and, lastly, the Investigating Officer (who carries out the investigations).

Goals categorized under management information and system support address the crime records management needs of Uganda Police Force top management, including the Inspector General of Police and Officers at the Criminal Intelligence and Investigations Directorate Headquarters.

Goals pertinent to systems administration represent the needs of the technical staff responsible for helpdesk and systems administration tasks.

III. Requirements Elicitation

Collecting system requirements from users and other stakeholders was undertaken using a multi-faceted approach. Salient amongst the techniques used were interviews with users and other stakeholders, joint requirements development workshops, user interface prototypes, document reviews, and best practices benchmarking. The choice of the elicitation technique used for each stakeholder was based on their domain knowledge and level of sophistication pertinent to the appreciation of the objective of the exercise. Table I gives a summary of the elicitation techniques used and the reason for their choice.

TABLE I.   Overview of Elicitation Techniques

| Technique	Application Context
User/ Stakeholder Interviews	Both closed and open interview methodologies [3] were used to establish the stakeholders' expectations. These interviews targeted stakeholders responsible for specific crime records management business processes guided by the prescribed system goals.
Best Practices Benchmarking	This technique was principally used to leverage existing knowledge and practice to develop technical and operational requirements such as requirements for authentication of users.
User Interface Prototypes	This technique was principally used to provide an opportunity to end users and other stakeholders to understand the envisioned system and provide insight on requirements that could have been left out bearing in mind that the end users had no experience with the product.
Joint Requirements Development Workshops	These workshops were organized to generate ideas, build consensus and foster stakeholder ownership. Different workshops were organised targeting the operational staff, middle tier managers and top management of the Uganda Police Force.
Study of Key Documents	The Penal Code Act, Police Operational Handbooks and Standard Police Forms were carefully studied to appreciate the crime records management business rules and link requirements to authentic sources.
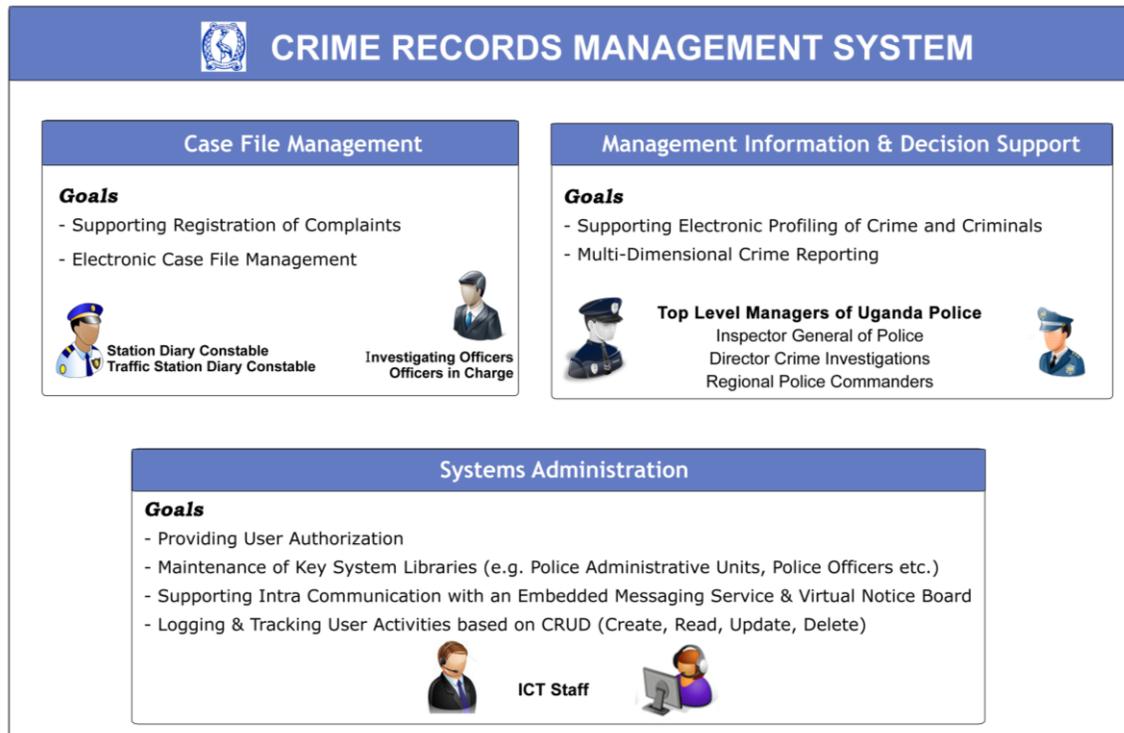
Fig. 1. Mapping of System Goals to Crime Records Management Roles

A. User/Stakeholder Interviews

The IEEE Computer Society asserts that interviews are particularly effective for understanding what stakeholders do and how they are most likely going to interact with the system [4]. Interviews were therefore used to gain an understanding of the crime records management business processes at the different Uganda Police Force functional units. The types of requirements elicited using interviews included functional, operational and transitional requirements. The interviews were conducted at four police stations in Kampala Metropolitan Police. Table II summarizes the selected stations and selection rationale.

TABLE II. SELECTED STATIONS AND SELECTION RATIONALE

Station	Rationale
Katwe Police Station	Busiest Police Station in Kampala Metropolitan Police. The station has a monthly turnover of over 400 cases. [5]
Central Police Station Kampala	Another busy station located in the heart of Kampala City with a monthly turnover of over 287 cases. [5]
Criminal Intelligence and Investigations Directorate	This station has very unique business processes given its nationwide coordination role for crime intelligence, investigations and associated knowledge management.
Uganda Police Headquarters	This station has unique business processes associated with systems administration and the Office of the Inspector General of Police.

B. Best Practices Bechmarking

Best Practices Benchmarking plays a critical role in directing the implementation of upcoming changes and sophisticated technological improvements [6]. The Uganda Police Force requested that the envisioned system should not have recurrent platform costs. The technical requirements pertinent to hosting, accessibility and security (data, application, and transport layer) were informed by case studies of proven similar web applications. Salient amongst the case studies were Google Search, Gmail, Trulia, Amazon, Interpol, and Yahoo Mail. Such case studies informed the requirements engineering process in the elicitation of requirements pertinent to user authorization and authentication, human computer interaction, transport layer security, notifications, and search optimization.

C. User Interface Prototypes

User Interface Prototyping was used as an iterative technique for actively involving users to facilitate elicitation of requirements within an environment that envisions the system. This approach was found productive, especially with the key operational staff associated with day-to-day crime records management tasks, such as station diary management, crime investigations and the development of the monthly/annual crime reports. The user interface prototypes informed the user experience development, especially from the functional viewpoint. The prototypes were developed using Axure Pro 6.

D. Joint Requirements Development Workshops

Stakeholder buy-in greatly contributes to project success [7]. Collaborative sessions were held with the objective of eliminating conflicting requirements and building consensus on the key functional requirements of the envisioned system.

Often such sessions brought together top management, key operational staff and systems analysts from the ARMS Project.

E. Study of Key Documents

A number of documents, including the *Penal Code Act*, the *Uganda Police Act*, the *Uganda Police Force Management Structure,* and the *Schedule of Responsibilities for Key Positions in the Uganda Police Force,* were studied with the aim of identifying business rules, procedure and guidelines associated with crime records management. Some of the requirements elicited using this technique were pertinent to classification of crime, definition of roles and responsibilities (e.g. responsibility for the station diary, investigations, compiling crime reports, etc.) and relationships between the different police administrative units (metropolitan, region, division, station and posts). This technique was also instrumental in the establishment of key business rules associated with crime records management such as flagging backlog cases, procedure for releasing suspects on police bond, and the framework for retrospective reporting.

IV. REQUIREMENTS ANALYSIS

The purpose of Requirements Analysis is to obtain a thorough and detailed understanding of the business need and to break it down into discrete requirements that are then clearly defined, reviewed and agreed upon with the customer decision-makers [8]. Having collected the requirements for the envisioned Uganda Police Force Crime Records Management System, requirements analysis was undertaken. The analysis was informed by six viewpoints briefly summarized in Table III [9].

TABLE III. VIEWPOINTS THAT INFORMED THE REQUIREMENTS ANALYSIS

Viewpoint	Description
Functional	The analysis from this viewpoint was aimed at identifying treacable requirements associated with the desired system capabilities. Use case analysis was used to walk through the primary interactions, responsibilities and interfaces of the defined functional requirements.
Information	The information viewpoint analysis focused on documenting the data elements pertinent to crime records management business operations. (For example, the data required about a suspect, witness, victim, complainant,and exhibit).
Development	From the development viewpoint, the interest was to establish the recommended practice to support the software development process, putting into perspective concerns such as construction, maintainability, open technologies, and testability.
Deployment	The analysis from this viewpoint focused on delieneating requirements pertinent to data center optimization, transport layer security, end user and technical training, disc storage facilities and disaster recovery.
Operational	The operational viewpoint analysis focused on identification of requirements pertinent to systems administration, configuration management and maintenance and support.

Guided by the viewpoints in Table III, the requirements were categorized into four major classes:

- functional requirements, impacting the business processes;
- technical requirements, impacting the system infrastructure;
- operational requirements, impacting system operation and support; and
- transitional requirements, impacting system implementation and change management.

It was then important to map each requirement to a traceable source (policy, guidelines, documented procedures, best practices benchmarking and standards) to eliminate the possibility of frivolous and spurious requirements. It was noted that some requirements were not feasible, considering that such requirements could not be linked to any authentic source. For example, the requirements associated with integrating features to support an open knowledge mining framework could not be linked to any authentic source or business rule.

A. Workflow Analysis

One of the techniques used in requirements traceability was workflow analysis. A step-by-step analysis of the workflow of each of the core functional units associated with crime records management was carried out. The major technique used was workflow diagramming. The functional units of interest were as follows:

- Crime intelligence and investigations: responsible for investigating crime and collecting, analyzing, and disseminating crime intelligence.
- Traffic department: responsible for handling complainants and cases associated with traffic and road safety.
- Minor contraventions department: responsible for handling misdemeanors and civil complaints.

Figure 2 is an illustration of the workflow at the crime intelligence and investigations department of a typical police station. The figure illustrates the end-to-end process for crime records management. The crime records management process in this case has four semi-autonomous stages namely; reception, investigation, prosecution and adjudication. On close examination of these stages, it was noted that the jurisdiction of police is at the reception and investigation stages. Prosecution is the jurisdiction of the Directorate of Public Prosecutions while Adjudication is the jurisdiction of the Judiciary of the Republic of Uganda. This delineation of responsibilities informed the scoping of the envisioned Crime Records Management System to business processes associated with reception and investigation. Microsoft Visio 2007 was used for modeling based on the UML 2.0 Specification.
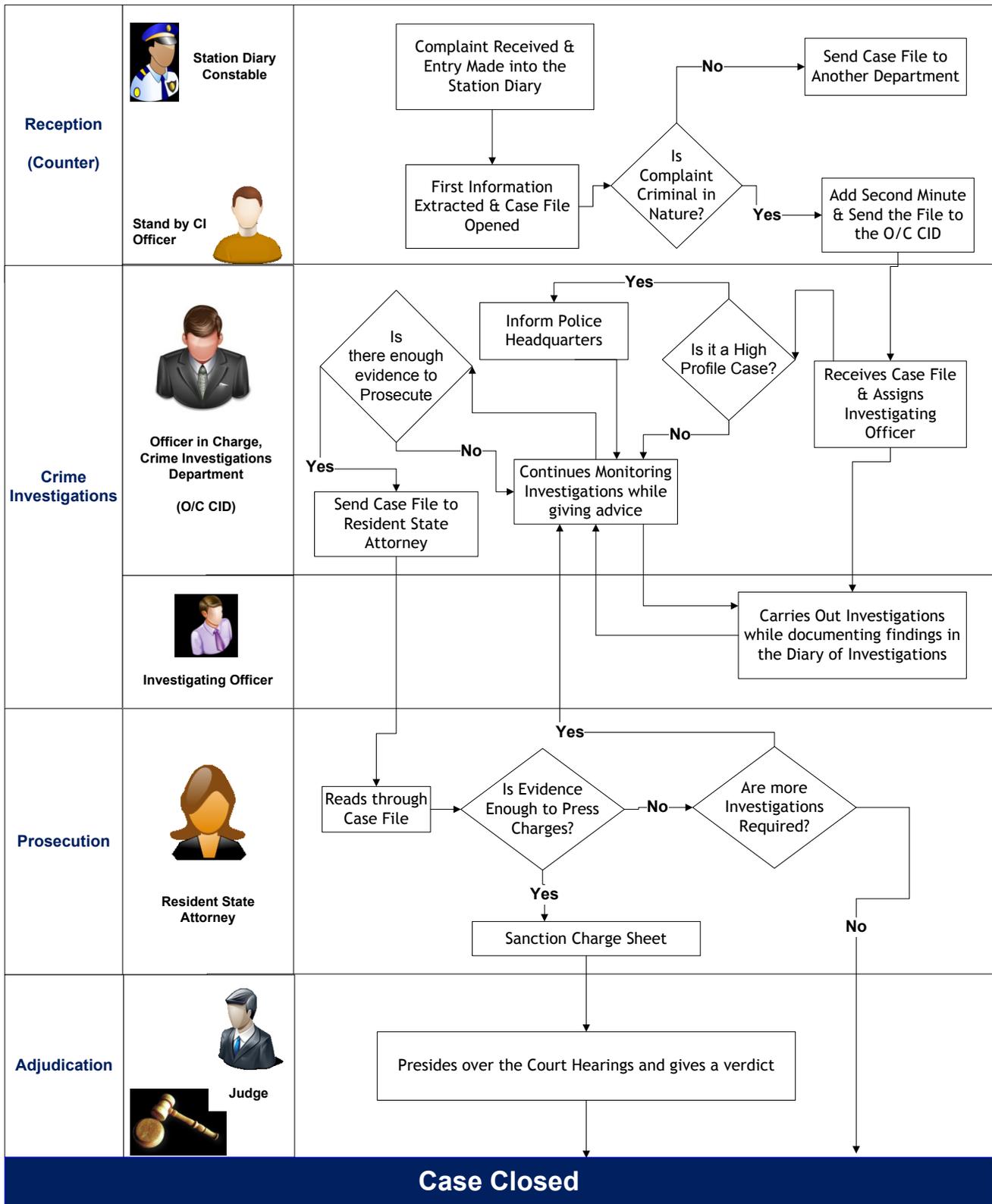
Fig. 2. Work Flow Diagram for the Crime Investigations Department

B. Requirements Prioritization

Prioritization of requirements is key to establishing what the system must accomplish (core requirements), what the system should accomplish (essential requirements) and what the system may accomplish (desirable requirements). All requirements were flagged with a priority index on the set {<C>, <E>, <D>: *Core, Essential, Desirable*}.

V. REQUIREMENTS SPECIFICATION

A System Requirements Specification (SyRS) was developed based on the IEEE Std. 1233-1998 (IEEE Guide for Developing System Requirements Specifications) [10]. The structure of the SyRS was informed by the requirements analysis documented in IV. Each requirement was assigned a unique paragraph number on the range X.Y – X.W.Y.Z. The SyRS was approved by the Directorate of ICT of the Uganda Police Force, Top Management of the Uganda Police Force and the ARMS Project, as a true representation of the requirements for the envisaged Crime Records Management System.

VI. CHALLENGES

The requirements engineering process pertinent to specification of requirements for the Uganda Police Force Crime Records Management System, though successful, was encumbered by several challenges.

- The mode of operation in the Uganda Police Force requires frequent transfers of police officers in the different units. These transfers negatively impacted the requirements engineering process given that whenever an officer was transferred, several accomplished undertakings had to be re-visited to bring the new officer up to speed. Consultations with the Uganda Police Force Top Management resulted in the designation of a dedicated team for the project. Consequently this team was a key resource during the deployment and validation phases of the project.

- The manual crime records management process had necessitated the creation of positions such as data entry clerks and records officers. Such positions would not be meaningful on the advent of an electronic system. Officers holding such positions in many cases attempted to influence the requirements engineering process in a direction that would specify untraceable and in some cases rather frivolous requirements. The requirements team was diligent about linking all requirements to authentic sources. Requirements which could not satisfy this criterion were considered invalid and were therefore not included in the system requirements specification.

- The Uganda Police Force team was mainly comprised of officers from the ICT Directorate. This resulted in partial elicitation of business process requirements on several occasions and thus a protracted requirements engineering process. Consultations with the Uganda Police Force Top Management resulted in the assignment of key operational staff to support the requirements engineering process and subsequent project stages.

VII. CONCLUSIONS

Successful requirements engineering requires objective and timely consultations with the client. Involving the end user in requirements engineering is paramount in defining correct requirements and avoiding re-work in the design and construction stages. Having representation from all functional departments of the client can go a long way in securing a good outlook of the functional requirements.

A knowledgeable and committed client team is very important in the requirement engineering process. The role of management support in the requirements engineering process cannot be overemphasized.

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