

## **Managing User Capabilities in Information Systems Life Cycle: Conceptual Modeling**

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### **Abstract**

Information Systems (IS) acquisition prescribes induction of information technologies (IT) in the organization. At times, IS is used for managing broader enterprise level issues like implementing e-business, e-commerce. Enterprise level issues are addressed through adequate involvement of people in the organization which are termed as “user capabilities”. Managing user capabilities is critical since their roles are very important in the entire Systems Development Life Cycle (SDLC). It is seen that failures in IT acquisition are not because of the technology, but failure in choosing it rightly, and poor user capabilities. If planned properly, user capabilities can contribute effectively to SDLC. SDLC works in stages with different sets of users and insensitivities to users contribute to the gap between satisfying organizational needs and end-user deliveries. This problem can be addressed by carefully integrating user capability issues in the SDLC process. In this paper a framework is suggested to capture user capabilities in an IT acquiring organization. User capabilities are identified in two categories: IT users who are IT experts and involved in design, development, and implementation of SDLC driven projects, and, second, non-IT users who, despite having inadequate or no exposure to IT, contribute to SDLC driven projects. The framework is implemented through Unified Modelling Language (UML) based approach. A case discusses the utility of this approach.

**Keywords:** User Capabilities, SDLC, Information Systems Modeling, UML.

### **Introduction**

It is a common notion that, once IT infrastructure is in place, it should be able to drive the organizational process successfully. Generally, acquisition of IT infrastructure brings a new technology to the organization and is directed towards addressing specific processes and at times towards a broader framework like implementing e-business, e-commerce, etc. IT acquisition, besides influencing the way process is handled (process re-engineering) in an organization, brings in effects on culture, and at times effects on its overall efficiency (Lamb and Kling, 2003).

Despite IT attaining the status of infrastructure, many organizations fail to leverage its full potential of the technology (Herron, 2002). Need-specific infrastructure probably will be suitable for an organization that is not dynamic, but the situation is not that ideal in real sense. Therefore, there is a need for developing and managing Information Systems (IS) with an aim to capture dynamic needs in an organization. Success of IT largely depends on how successfully IS planning is done in an organization, and how good the organization is at

pursuing decision making style. Studies (Lycett *et al.*, 2003) indicate that 80 to 90 per cent of software does not meet performance goals, 80 per cent of them are delivered late and over budget, 40 per cent of developments fail or are abandoned, less than 25 per cent of systems properly integrate business and technology objectives, and only 10 to 20 per cent meet their success criteria. Thus there has been a growing concern over evaluating, managing, and measuring effectiveness of IT infrastructure acquired (Misra, 2008).

Despite the challenges and limitations in capturing user capabilities, software engineering principles are deployed constantly in organizations. The organization goes through various SDLC driven projects to acquire IT infrastructure. Though SDLC driven projects have their advantages for a project management and other various models do provide project management techniques, they are not free from limitations in capturing organizational business value at macro level (Lamb and Kling, 2003). These limitations include failure of user to educate the developer and vice versa. SDLC recognizes the fact that ultimate success of any IT infrastructure acquired would depend on the way end-users use it. End-user competence and their attitude towards the IT usage have direct impact on its successful use. Thus there is a scope to understand user's involvement in the IT acquisition process. This is a complex phenomenon since users span across all layers in the organization, they involve in technology driven processes and also liaise with technology providers.

The organization of the paper is as follows: In section two SDLC and its relationship with organization is discussed. In section three, user capabilities are discussed with respect to IT acquisition life cycles. In section four, a framework is presented which reflects some of the issues related to building user capabilities in the acquiring organization. In section five, Unified Modelling Language (UML) has been applied to explain the usability of the framework presented; analyses of results are also discussed in this section through a case. In section six, the paper is concluded with a discussion on future work.

### **Sdlc Approach**

During the early stage of IT acquisition, managing IT activities relating to operation, programming, and data collection were the major areas of concern. In later stages the focus was on establishing a unit to look after various types of applications over an extended lifecycle, despite change in technology. Simultaneously, emphasis to involve users developed not because of business priorities, but to enable easy use of applications computerized. However, a review of IS/IT has been occasional in organizations (Frank, 1998). Two areas of concern, emerged in the early 1970s, "Data Processing (DP)" and "Management Information System (MIS)". In the early 1980s, a third area of concern evolved, i.e., strategy for leveraging lessons learned from DP and MIS (Flynn, 1998). DP approach was focused to ensure automation through IS/IT of the processes to achieve required efficiency.

Ideally systems design commences at the fag-end of the strategic planning process and should be on project mode after this point of time. But normally the project cycle starts immediately after some requirements are set for the organization and the vendor embarks on executing the project. Researchers argue that IS need not be IT-centric, but efficient and/or effective operation of IS depends on the use of IT. Therefore, there should be a strong orientation of IS towards work system rather than becoming IT-centric. In this context the

organization and IT just coexist and need not be independent (Wang and Tai 2003). In order to make an application or IT acquisition successful, focusing on technology alone will not help, but there should be clear understanding on the distinction between “IS Strategy” and “IT Strategy”. However, in reality, organizations grow to be complex and this becomes more complex when users at all levels demand pervasive use of IT (Basili et al., 1994; Nuseibeh and Easterbrook 2000). This leads to a phenomenon called “IS demand” and “IT supply”. An alignment between these two elements is vital for an organization.

Modern Systems Analysis and Design (SA&D) and SDLC methods recognize user-interface designs (Lycett et al., 2003). However, these issues are addressed during the design stages of SDLC. In this stage the users interact with the project team. But it is essential that the requirement engineering stage is meticulously followed prior to embarking on SDLC. In this stage the acquiring organization needs to strategize involvement of users to capture their requirements. The capabilities of users to collaborate in the process are important at this stage to bridge the gap among IT experts, process owners, and IT users in general. Involvement of users at this stage is expected to influence their usability behaviour to a great extent in the subsequent stages of SDLC (Broadbent et al., 1996; Herron, 2002).

SDLC process provides an opportunity to systems planners to install IS through user participation, capturing user requirements and incorporating them appropriately. Modern SDLC models are based more on organizational needs than human needs. People play different roles in SDLC in which their roles carry immense value. These roles are primarily end-users, planners, and domain experts (IT and non-IT). SDLC, though is organization-centric with strong bias to information systems than information technology, it is not free from some serious limitations. One of them is the way the SDLC is organized for freezing the milestones and then referring back in case it is needed after execution of the stage. Another dimension of the criticism is the offshoot of the first one leading to high maintenance cost because of lack of time that SDLC provides for analysis and design. Structured analysis and Object Oriented Analysis and Design (OOAD) were thought of providing a better solution to ensure good conduct of the project under process approach. The third dimension of the limitation of SDLC is its suitability in project specific delivery. Most organizations use different life cycle models for different projects such as waterfall, spiral, commercial off the shelf (COTS), incremental, and evolutionary model to name a few (Basili and Barry, 2001). However, it is difficult to ascertain the survivability of the system thus developed for its expected life cycle. It is argued that most of the models popularly coming under SDLC have limitations in delivering good result in a complex scenario, but are successful in a tightly specified domain. All software models under SDLC can be characterized as a problem-solving loop, which may go through four distinct stages: status quo, problem definition, solution integration, post-acquisition assessment. Status quo represents current status, problem definition identifies the specific problem to be solved, and technical development solves the problem through application of some technology (Boehm and Hansen, 2001).

### **User Capabilities**

IT acquisition in an organization is termed successful if its people can leverage the presence of IT through effective use and can understand the way IT needs to be used.

Definition of user is broad based. Users assume the role of end-users, technology managers, and technology suppliers as well. In this section we look at users in an acquiring organization. Users span across all levels in the organization: “strategic”, “tactical” and “operational levels”; IT managers, and developers representing the acquiring organization.

It may be noted that users of IT perform their roles differently at different levels and their requirement varies. This is also true when we discuss about IT requirements which need to be detailed for the organization. One of the issues in the acquisition process is to involve users to understand the purpose of providing a systemic environment for their work. Operational users form the core group who perform iterative process oriented transactions. Maturity at this level provides the organization a tool to organize data processing effectively. This in turn would help the next upper layer called “tactical users” (Boehm and Hansen, 2001; Davis and Olson, 2000). This capability of tactical users provides a leadership to operational users and monitors the requirements of “strategic users”. Strategic users who often involved in the decision making process tend to use the IT infrastructure sparingly and depend heavily on tactical users to feed on (Corinne and Muthu, 2008; Pervan, 1998). This environment imposes restrictions on tactical users to meet the requirement at short notice. With the functional expertise they tend to focus on structured reports that get generated at the operational level, evaluate, and analyze as the situation demands. Tactical users, the interface layer between strategic and operational users, therefore, are the most critical mass in the decision-making process that provides analytical features to the data processed (Bowen *et al.*, 2002). Another set of users that should not be ignored is IT managers and related workforce. These users are not only the immediate beneficiary of IT but their role in the pre-acquisition process also is of paramount importance. Capacity building of these users would enhance the pre-acquisition IT planning process, manage IS-IT alignment process effectively at the strategic level and bridge the gap between IS and IT planned. Tactical level IT experts form the backbone of the IT architecture providing an interface between the tool specific users for developing the IT component based infrastructure (Lee, 2001; Luftman, 2003).

### *User Stratification Under SDLC*

SDLC-driven projects aim to conceptualize, design, develop, and deploy user-centered services which could survive a considerable life cycle so that desired services are garnered for meeting organizational objectives among all the defined set of users. SDLC activities provide a detailed and sequential approach to bringing together organizational priorities, user expectations, and system deliverables (Shaw and Garlan 1996). SDLC-driven projects have three distinct stages which could provide an insight to user capabilities as presented in Table 1. These stages are “pre-acquisition”, “acquisition” and “post-acquisition”. SDLC needs a careful articulation of system requirements through process mapping, establishing relationships among process as envisaged at the organizational architecture, and binding all systemic parameters to these processes. In the post-acquisition stage, SDLC prepares the project planners and managers to test the planned deliveries and measure their successes through user-driven tests and feedback. This stage reflects an end-user motivation to use the IT enabled processes for a desired life cycle. It is argued that there are three distinct levels of users in an organization to carry out SDLC mandates (Mead *et al.*, 2000; Piekarski and

Plimmer, 2007).

Thus it is important to consider that IT infrastructure acquisition is a larger organizational issue and is viewed as an opportunity in which various stakeholders converge together to set up, own and maintain the acquired infrastructure. These stakeholders are primarily the users who assume the role of end-users, IT suppliers, IT managers, and functional planners. It is apparent from the last few decades of IS research that organizations face a plethora of user related challenges and user capability is one of them. In general, user capability is concerned with the way humans interact with information systems, the ways they prefer to use IT as a tool and accomplish tasks given to them. Therefore, user capability largely depends on maturity levels in the organization's processes, technology acquisition environment, and people.

Table 1  
*Role of Users in SDLC*

SDLC Activities	Stage of SDLC	Critical Success Factors	User Roles (Capabilities)
Mission Definition	Pre-Acquisition Stage	Macro deliveries are captured	Able to formulate long term delivery plans
Concept of Operations		Formulation of standard operating procedure	Able to outline process capabilities
Project Planning		Processes are prioritized and sequenced	Able to engineer process deliveries and interface them
Requirement Definition		Process outputs and outcomes are organized	Able to fine tune process output, outcomes
Systems Specification		Development of road map for functional deliveries	Able to relate domain specific outputs to organization's mandate
Systems Architecture	Acquisition Stage	"Fit" between organization structure and systems structure	Able to relate overall systems deliveries to macro perspective of organizational deliveries
Systems Design		Proper development and verification of systems behaviour	Able to design systems behaviour
Systems Implementation		Efficient coding and operation of systems	Able to measure system deliveries
Systems Testing		Survive tests, quality parameters and standards	Able to test the systems as per organizational priorities
Systems Evolution		Proactive measures to specify improvement	Able to refine systems behaviour
Systems Usability	Post -Acquisition Stage	Systems are easy to use	Able to adapt to the environment
Systems Use		Physical behaviour of systems	Able to spread systems use
Systems Usefulness		Sustained use of systems	Able to provide inputs for systems improvement

In this work, users are organized in three broad categories: “IT users”, “non-IT users” and “IT vendors”. While IT vendors could be essentially IT component providers like databases, networks, hardware and software; first two user categories are mostly considered as internal to the organization’s human resource. These users play active roles in their own domain as explained in Table 2. Human resource in the organization is stratified mostly into three levels - strategic, tactical, and operational. In each stage of the acquisition process, user capabilities would vary (Luftman, 2003). It is therefore, necessary to relate SDLC stages to the stratification of users as shown in Table 2. In the following sub-sections this relationship is discussed (Misra, 2008; Ping et al., 2005; Vijay et al., 2008).

Table 2

*Role of User Capabilities in SDLC*

Human Resource Classification and the Role		
User Categories	Roles	Domain knowledge
Operational non-IT users	Accesses the IT enabled system through an interface; need not have knowledge on IT	Specialists in managing process specific transactions
Operational IT users	Mostly programmers, logistics management	Tool specific skills
Functional non-IT users	Business process owners involved in management reporting, inter-function coordination. A critical layer to support IT use	High on business process knowledge; less exposure to IT use
Functional IT users	System developers/analysts/ architects with high exposure to IT tool planning, but a potential layer to appreciate business process	Moderate exposure to business process. Good knowledge in IT component selection process and its management
Strategic non-IT users	Involved in strategic business plan, needs highly dynamic reporting environment with inter-functional support. Looks for coordinated information systems	Aware of organizational issues, frames strategy for business, and provides direction. A critical layer to introduce IT
Strategic IT users	High exposure to IT planning, understands business practices and appreciates the need for inter-functional interfaces and overall delivery of IT	Strategic focus on IT. A critical layer to assist the strategic end user to establish the IT roadmap.
IT vendors	Project management capabilities, component planning	End-user interface designs

*Non-IT Users and SDLC*

Stages of IT acquisition in IT-acquiring organization can be as shown in Figure 1 (Ward et al., 1990). It explains that “Initiation” stage begins with the business need. This need could be a part of the larger business plan formulated in the organization. In “planning” stage, project team is formed or the IT team takes over the planning process with a pre determined goal. Requirement determination and prioritization of the project delivery are formulated in this stage. Vendor relationship is developed in this stage as well. The third stage involves

“research” in the market, benchmarking similar projects in order to assess vendor credibility, product suitability, cost, time efficiency and effectiveness etc., of the project at hand.

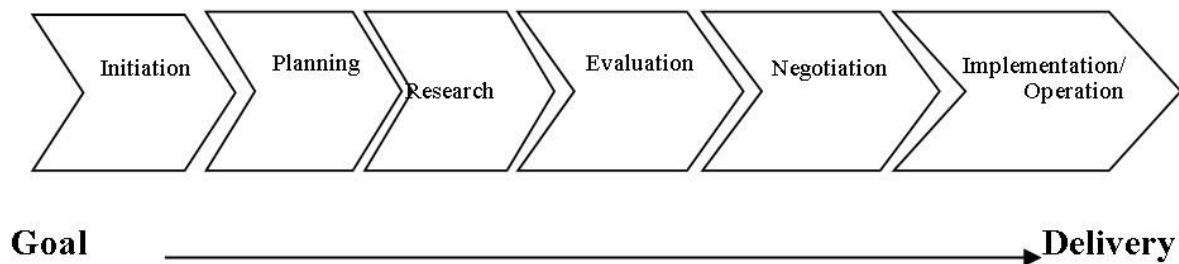


Figure 1: Sample IT Acquisition Process

Tendering process and vendor evaluation for the product and/or process takes place in “evaluation” and “negotiation” stages. “Implementation” and “operation” stages are last stages of the acquisition process where delivered product(s) are assessed, evaluated and implemented with the help of users. Since mostly software is the central issue, it is the driver for testing the IT infrastructure thus built for the purpose. In each stage capability of the acquiring organization is ensured for successful execution of the project (Jalote, 2002).

Another important dimension of organizational capabilities is “adherence to quality”. Software Acquisition-CMM (SA-CMM) is one of the quality models associated with it. The model tries to understand the acquisition process through management plan for acquisition and software risk assessment. Each acquisition project germinates with a requirement, albeit at a high level. At times the IT manager pushes an idea to introduce IT enabled services. As the acquisition begins to form, more requirements are identified and refined. This evolution precedes and the set of requirements continues to grow. By the time the solicitation package is developed, a significant set of software technical and non-technical requirements exists. For the purpose of SA-CMM, these requirements must be base-lined (managed and controlled), not frozen. As software requirements further evolve (e.g. allocation, elaboration, and refinement) they are incorporated into the requirement baseline and managed and controlled. Management and control remain the acquirer’s responsibility even though the contractor may be involved in the requirements development process. SA-CMM is based on the expectation that a mature organization and its projects will do a thorough job of planning an acquisition. SA-CMM accommodates the software that is acquired as part of total system acquisition. It does not specifically address the system acquisition process; however, it is in harmony with that process. SA-CMM focuses on building the process capability of an organization (Grady, 1992; Leffingwell, 2007; Watson *et al.*, 1998).

### *It Users and SDLC*

In IT acquisition it is the responsibility of the IT service provider to display its credibility. In some cases it has to guide the IT acquiring organization to understand all aspects of the technology and various options that can be considered before taking a decision. Ways of displaying such credibility and competence could be in the form of acquiring quality certification manufacturing through maintenance, past established experiences and the

strength of the organization. This competence should also be reflected in the product being supplied. There are various models which attempt to increase the level of understanding the issues and raise the level of expertise in approaching for this type of IT acquisition. Certifying organizations like the International Standards Organization (ISO) have effectively worked on various models and suggested guidelines, procedures that may be adopted by IT vendors. Most of these models have focused on process improvements. Some of the important models refer to the perspective of IT service providers (suppliers) who acquire the technology as well as use it to provide a product and/or service to the acquiring organization (Misra and Mohanty 2003). The reasoning behind developing these models is to effectively put in place a quality system that can manage the process of acquisition. The basic idea behind developing quality systems (Flynn, 1998) is to formalize a process which would provide a tool for stakeholders to assess each other. Besides, it also would enhance the understanding of the buyer. Obviously, a big part of building trust rests on the vendor being able to guarantee that it can deliver on commitments. At the same time the vendor should also look at the intrinsic factors that could affect the quality of IT components and/or implementation of the IT project in the acquiring organization.

“Usability capability” of the product and/or services is an indicator that provides a better understanding of the credibility of the supplier, developer, and organization. User Centred Design (UCD) methods of ISO 13407 can be used for development of software that might add to the credibility of software as well as product quality. “Usability” is defined as one of the main software quality attributes in standard ISO 9216.

IT service provider can organize its usability capability so that the user can use the product developed or supplied (Lientz and Chen,1981; Abrahamson and Jokela ,2001). Usability capability models like Trillium, Philips, INUSE human centeredness (INUSE HCS), and International Business Machine (IBM) profess some capability statements for software development agencies. Since IT acquisition is software centric, these models make sense to discuss about. However, “how far will it be applicable to IT acquisition as a whole” is to be deliberated. It is also said that usability is quality characteristic of a product that is determined by the content and quality of UCD. “Usability” gives many benefits like increased productivity, enhanced quality of work, improved user satisfaction, reduction in support, and training costs(Abrahamson and Jokela 2001). ISO 13407 defines a set of principles aimed at allocating functions between systems and users, iteration of design solutions, active involvement of users, and a multi-disciplinary teamwork. These activities should be performed seriously in order to produce valid data for product design. This calls for skill sets, tools, and methods to carryout the process well and therefore determines and displays the capability of the product developer for evaluation by an IT acquirer and provides scope to build trust(Lientz and Chen,1981).

It is opined that many products in the market or systems that are in use have poor usability (Lee, 2001). A typical approach to start organizational improvement effort in any domain is to carry out current state analysis to identify the strengths and weaknesses and thus get a good basis for planning and implementing process improvement techniques. Well known approaches for software processes are Capability Maturity Model (CMM), Bootstrap, and ISO 15504 (also known as SPICE). But this does not guarantee success of IT acquisition



as a whole. Each component of the IT infrastructure has distinct issues and a holistic approach needs to be adopted.

### *It User's Capability Under Product Approach*

Under a product based acquisition, many issues such as delivery attributes and input characteristics are already addressed. Processes are also predetermined and imposed on the acquirer. In this case it is the manufacturer's credibility and competence that plays a vital role in accepting and using the product. Similar is the case with any middleware and firmware products.

Enterprise Resource Planning (ERP) is built upon certain middleware products and compatible with various OS available in the market. But a serious problem it brings in to the acquiring organization is the process of implementation. Despite growing popularity of ERP packages, this warning is still valid. Surveys indicate that ERP systems are viewed to be the most strategic computing platform in an organization. But the alarming finding is that 60 per cent of ERP projects have been judged unsuccessful by ERP implementing firms. This is also attributed to the "mis-fit" in the customer's desire for meeting their specific need for unique business solution and the vendor's generic applications and "inflexible" module. Thus a product must qualify to meet the user's requirements. Other IT components such as networks, middleware, and firmware, do not having such problems because these are used for developing and using application software which capture the process intelligence. For example, US firms in 1996 invested around US\$275 billion in software application and 53 per cent of the projects failed not because of wrong codes, but because of their failure to understand the real organizational needs and systems required to solve the problems and meet the objectives. Therefore, IT service providers must be capable of portraying competence to understand the need of the IT acquiring organization and then prescribe IT components for selection and acquisition. It is also argued that failure of process approach for implementation of ERP is strongly related to social interaction of IT and organization through architectures (Basili and Barry, 2001; Kumar and Hillegersberg, 2000; Shaw and Garlan, 1996).

### *It User's Capability Under Process Approach*

IT service providers need to take up the organizational processes for automation as desired. This introduces a complex phenomenon called "gap" between the knowledge of the vendor and the organization's requirement. Attempts are being made to bridge the "gap" between the two. In order to have glance at the available models which are all-inclusive but not exhaustive, possible quality models with the utilities are described below for the "software engineering approach" that talks about processes by which products are built and implemented as per user's requirements. The other category called "quality acquisition approach" describes models, standards, and systems available for assessing capability or approaches made by the supplier and purchaser for IT acquisition. With the advent of Computer Aided Software Engineering (CASE) tools along with Object Oriented Application Development (OOAD) techniques, IT service providers can develop and manage software projects.

Several formal methods such as “information engineering”, “structured systems analysis and design”, Jackson System Development (JSD), “Structure Systems Analysis and Design Method (SSADM)” and “Object Oriented Modelling Technique (OMT)” (Kumar and Hillegersberg, 2000) have evolved over the years to provide an insight to the IT service provider’s capability. But these methods do not provide any guarantee to deliver a product that would suit the user’s requirement since all these are in project management mode. These methods do not provide support to manage change in user’s requirements, or allow the users to refine and reflect in the product delivered. User’s knowledge is scantily represented in these methods(Wohlin et al., 2000,Pervan, 1998).

### Proposed Framework

In the framework, three stages discussed in Table 1 are considered important in an acquisition cycle. It is argued that users at all levels (strategic, tactical, and operational) in the organization are critical contributors to SDLC as discussed in Section 3. As shown in Figure 6 Planning and Policy (PP), Project Management (PM), and User Motivation (UM) cover all these strataof users respectively. These sets of users are involved in planning and execution of SDLC driven projects. Their capabilities do influence in the overall acquisition process. PP is part of strategic user responsibilities whereas PM capabilities are contributed by tactical (domain specific) and strategic users. User motivations are dependent on individual users across all levels since they contribute collectively through overall climate, culture, and recognition norms available in the organization. User motivation (displayed by leadership in the organization), IS and IT plans (planning and policy), organization environment to understand and accept IT, people’s perceptions of IT, and a good decision model to lead the technology are essential contributors to “non-IT users capabilities” (ONITUC) in this model. IT users are also recognised at all three levels in the organization; i.e. strategic - Chief Information Officer (CIO), tactical-Systems managers and operational (programmers, application developers, etc.). These IT users need a collaborative mechanism to direct the acquisition process by identifying right IT vender capabilities (ITVC), developing and deploying right IT infrastructures, and establish usable systems. This capability is termed as

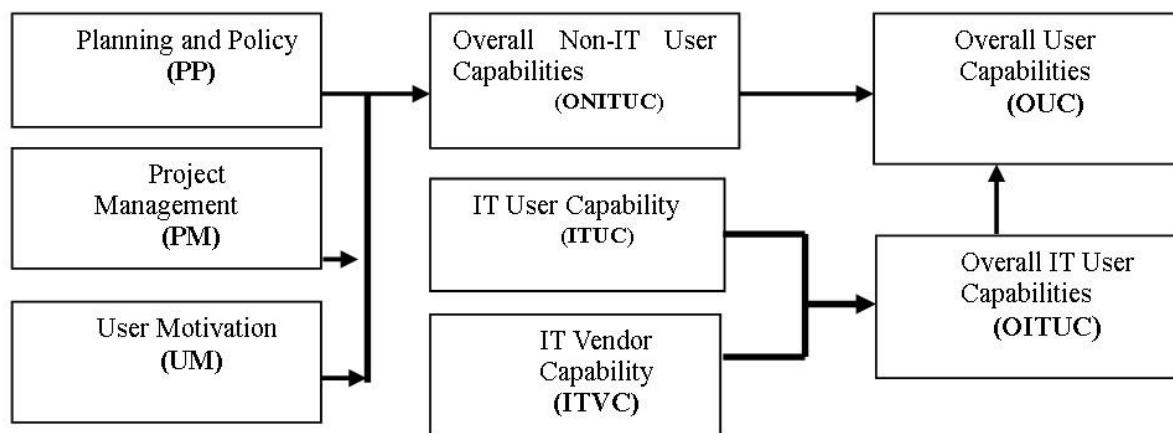


Figure 2: The Capability Management Model

“IT User Capability” (ITUC). ITUC and ITVC contribute to overall IT user capabilities (OITUC). Consequently the model considers that overall user capabilities (OUC) are influenced by ONITUC and OITUC. A model is an abstract representation of reality and supports decomposition (Sophie 2001). The framework in Figure 2 shows the variables denoting the contributors to user capabilities and their corresponding relationships (Pervan, 1998; Mead et al., 2000; Ward et al., 1990; Misra, 2008).

Each variable in the model has specific contribution to assessment as explained in Table 3 based on the dependency. This dependency is considered unidirectional since the stages in the acquisition process are sequential. In stage I (pre-acquisition stage), systems planning, project management strategies and prioritization of activities are included and these require capabilities of both IT and non-IT users. In stage II (acquisition stage), infrastructure and services as planned in stage I are acquired. In the post-acquisition stage (stage III), SDLC projects provide scope for IT and non-IT users to assess the usability, actual use, and usefulness of the services rendered. Therefore, it is essential that these user segments display certain traits to internalize the issues related IT infrastructure acquisition.

Table 3

*Dependency Matrix*

Dependency	Explanation	SDLC Stage Imperatives
ONITUC= $d^*$ (PP, PM, UM)	Non-IT User Capabilities <i>depend</i> on planning and policy, Project management capability and user motivation	Pre-Acquisition Stage of SDLC (IT and Non-IT users); Stage I
OITUC= $d^*$ (ITUC, ITVC)	IT User Capabilities <i>depend</i> on the capability of the IT department and vendor capability to manage projects	Acquisition Stage (IT Users); Stage II
OUC= $d^*$ (ONITUC, OITUC)	Overall User Capabilities in an Organization would <i>depend</i> on organization's Non-IT and IT User Capabilities	Post Acquisition Stage (IT and Non-IT Users); Stage III

\* ‘d’ denotes Predictive Dependency (Ward et al.,1990; Misra, 2008)

### Case of UML Based Modelling

Modelling is very critical to reflect upon organizational activities at macro level. Models provide the desired time and space to collaborate, debate, and agree on organization level issues, complex delivery processes, and possible outcomes of the strategic exercises. Models are used to display approximately defined behaviour of real-life situations through simulated environments and thus provide macro views of micro components arranged to work towards a unified view. Models thus can be used for different views (Lycett et al., 2003). In an IT acquisition scenario, such views are necessary since systems tend to capture organizational objectives dynamically. As explained in section 1, traditional SDLC is generally practised for systems development and acquisition in organizations. There are various SDLC models for the purpose of systems development. UML is often used for process modelling and is covered by ISO/IECS-19501 (Pervan, 1998). UML provides modelling with platform independence. Since it is a process modelling tool and the framework is presented to understand and reflect

the dependencies of various capability variables iteratively, UML is adopted to reflect them (Mellor and Marc, 2002; Rumbaugh *et al.*, 1999). Application of UML for reflecting capabilities in SDLC driven projects does have critical influence since user capabilities are agile and need to be captured iteratively (Misra, 2009).

### *Uml Based Sdlc User Capability Modelling*

SDLC is a conceptual model having various methods for managing software engineering processes. It requires continuous requirement acquisition and user capabilities need to be assessed at these stages in an organization. Business models often reflect various views of the processes and these views need to be well articulated in SDLC. Thus UML a modelling language, which can be used to specify, visualize, and construct these views of the business models can be used at any point of time of the SDLC process. This would be especially relevant in the initial stages of the IT acquisition cycle.

UML has emerged as an industry standard which combines object orientation and component modelling. It provides a developer and the business modeller to collaborate and map organizational processes through various interactive components. It therefore provides a link for IT users and non-IT users to collaborate and bring in the right ambience to contribute to the larger complex process of mapping automation principles to existing and real organizational processes. Executable UML approach has now enabled the developer to directly generate codes from abstracted UML driven models which can be modified at the micro level (Mellor and Marc 2002). This enables the non-IT user to collaborate and contribute to the abstracted models for organizational process and collaborate with IT users for effective development and deployment of applications. This also helps in incorporating changes arising from evolving end-user requirements. Therefore, there is a need for the acquiring organization to support and motivate end users to collaborate and engage with IT-users continuously.

In Table 4, user capabilities are presented with specific reference to UML characteristics. SDLC driven projects also provide similar situations where all users collaborate in the project life cycle. In this table various activities of SDLC are described in which the defined users play their role specific to each activity. These activities are considered relevant in three stages of IT acquisition (pre-acquisition, acquisition, and post-acquisition). In these stages user responsibilities and unique and they need to deliver as per the demands of SDLC. Generally, organizations are agile and requirements change according to forces influencing internal processes and external interfaces (Larman, 2004). Bringing all the agile issues into the ambit of application development projects is a complex phenomenon and UML supports this process through its various views and areas (Rumbaugh *et al.*, 1999) as presented in Table 3. Various important views are “Static”, “Use Case”, Interaction”, “Model Management”, “State Machine”, “Activity”, “Implementation” and “Deployment”. The areas are “Structural”, “Dynamic”, “Model Management” and “Extensibility”. UML generates various diagrams which incorporates and represents user intentions and these are “Package”, “Communication”, “Uses Case”, “Sequence”, “Class”, “Component”, “Activity”, State Machine” and “Deployment”. Thus there is an opportunity created by UML process-driven projects to provide a model driven approach to users to effectively contribute to SDLC driven projects.

This approach also provides an insight to user capability indicators in each stage of SDLC and the UML processes adopted for a project.

Table 4  
*Mapping User Capabilities in SDLC through UML*

SDLC Activities	Stage of SDLC	UML Processes	Related User Capabilities
Mission Definition	Pre-Acquisition Stage (Stage I)	Package Diagram, Communication Diagram, Activity Diagram	Strategic Non-IT users' capability to contribute to static views for the system (Structural Areas)
Concept of Operations			Strategic users' capability to contribute to the meta model (Static View and Structural Areas)
Project Planning		Use Case Diagram, Sequence Diagram	Static views of strategic non-IT users and strategic IT-users for formalizing the meta model, relationships and generalization of deliveries at the enterprise level (Use Case View and Structural Areas)
Requirement Definition			
Systems Specification		Class Diagram	Capabilities of strategic IT-users and functional non-IT Users to contribute to enterprise systems design and deliverables for each system (Implementation View and Structural Areas)
Systems Architecture	Acquisition Stage (Stage II)	Component Diagram, Communication Diagram	Capabilities of strategic IT-users and functional non-IT users to contribute to establish relationships among systems specified (Static View and Structural Areas)
Systems Design		Activity Diagram, State Machine Diagram, Sequence Diagram	Capabilities of tactical IT –users and functional non-IT users to detail processes, process deliveries, and sequencing processes. (Dynamic Areas and Interaction view)
Systems Implementation		Deployment Diagram	Capabilities of strategic, tactical IT, and non-IT users to encourage common users for implementation of systems (Static views, Structural Areas)
Systems Testing		State Machine Diagram, Communication Diagram	Capabilities of tactical and operational non-IT users and IT users to validate the desired services of systems (Static Views, Deployment Views; Structural Areas and Dynamic Areas)
Systems Evolution	Post -Acquisition Stage (Stage III)	Class Diagram, State Machine Diagram	Capabilities of strategic IT and non-IT users to contribute to systems improvement and business process engineering (Model Management View)
Systems Usability		Class Diagram, Deployment Diagram, Communication Diagram	Capabilities of non-IT users (Strategic, Tactical and Operational) to contribute to make the systems usable; capabilities of IT users to ensure development of systems that are in conformity with non-IT users' expectations (Interaction View and Dynamic Area)

SDLC Activities	Stage of SDLC	UML Processes	Related User Capabilities
Systems Use		Deployment Diagram, Sequence Diagram	Capabilities of strategic and tactical non-IT users to ensure that systems developed are in use; operational users accept the systems automated. Capabilities of IT users to motivate non-IT users to use the system. (Implementation View and Deployment View with Structural Area and Extensibility Area )
Systems Usefulness		Use Case Diagram, State Chart Diagram	Capabilities of non-IT Users to display the usefulness of systems developed and outline scope for improvement (State Machine View, Activity View, Interaction View with Dynamic Area; Model Management View)

Source: (Rumbaugh *et al.*, 1999; Mellor and Marc, 2002)

Discussions made above are presented for providing a panoramic view of the mapping process through deployment of SDLC-UML. Examples of various diagrams are presented for appreciation of the SDLC and UML driven processes. It is noted that various diagrams can be used in three distinct stages of SDLC driven projects.

- Activity Diagrams: UML uses activity diagrams to capture business process, activities in sequence, objects interfaced, and dependencies among activities (Rumbaugh *et al.*, 1999). In this case this “activity diagram” is used for capturing the entire process of assessing organizational capabilities (OUC) which is assessed through the framework as sequenced in Figure 3, Table 3, and Table 4.

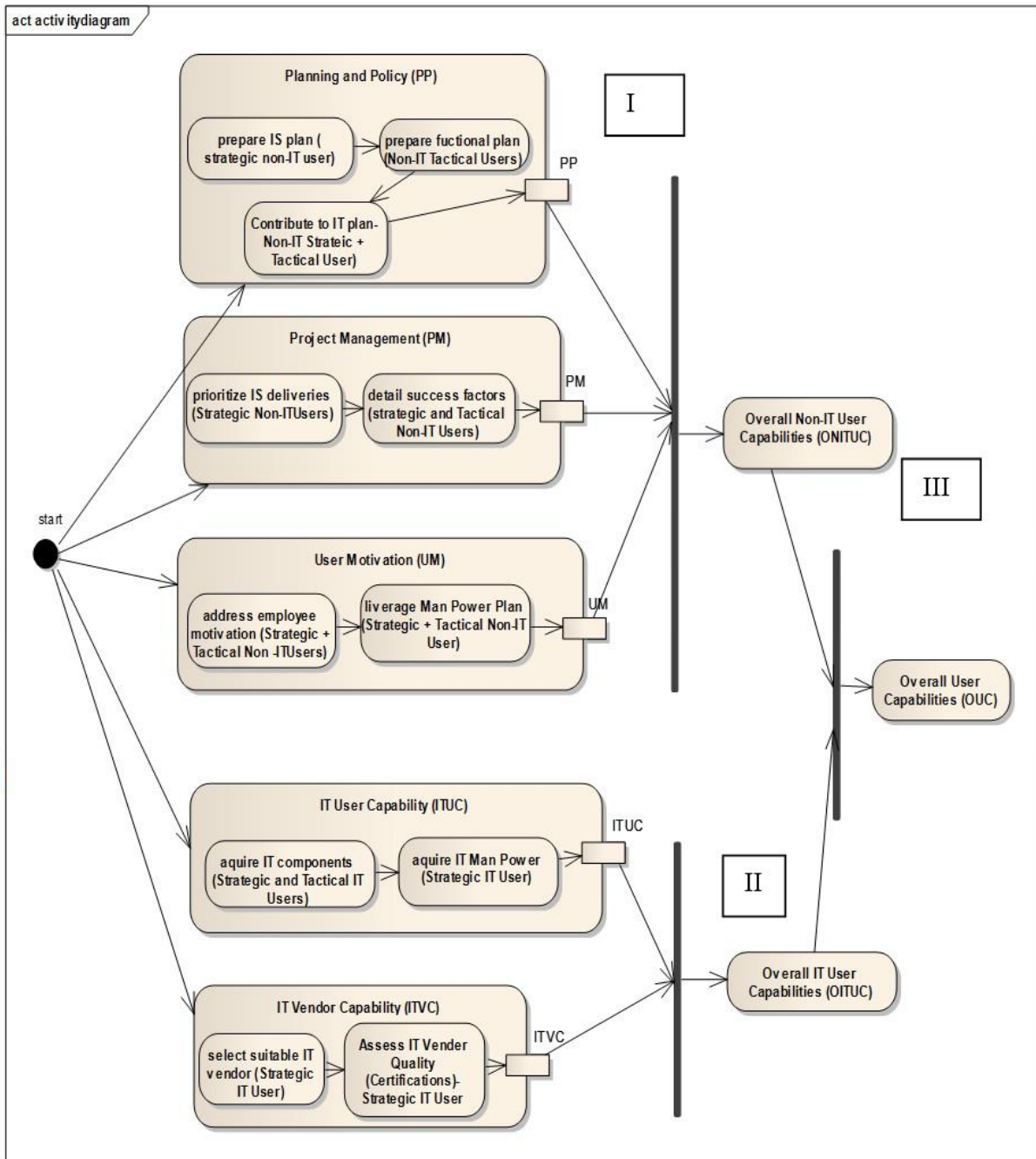


Figure 3: Activity Diagram

- In the presented activity diagram, three stages are involved to manage the SDLC in an organization to capture capabilities. In stage I, non-IT user capabilities are captured and they can be assessed in each layer as explained in Table 2. These capabilities are to be aggregated for further assessment. In stage II, IT capabilities are assessed through evaluation capabilities of the IT department, its acquisition capabilities including IT vendor identification and management. In stage III, aggregation of stages I and II are managed to understand the overall capabilities scenario in the organization.

- Capturing Business Structural Views (Sequence Diagrams):** This is an important exercise though UML modeling which captures capabilities requirements at various levels as described in Table 4. This is explained through a “sequence diagram” in Figure 4. In the diagram, prioritizations of activities are presented. Stage I is sequenced first since non-I users are expected to spearhead the IS planning process and prioritize the planning of IS deliveries. Stage II involves collaboration of all IT and non-IT users to manage the projects identified, requirements elicited, and reflection of organizational behaviour and processes in IT-enabled processes.

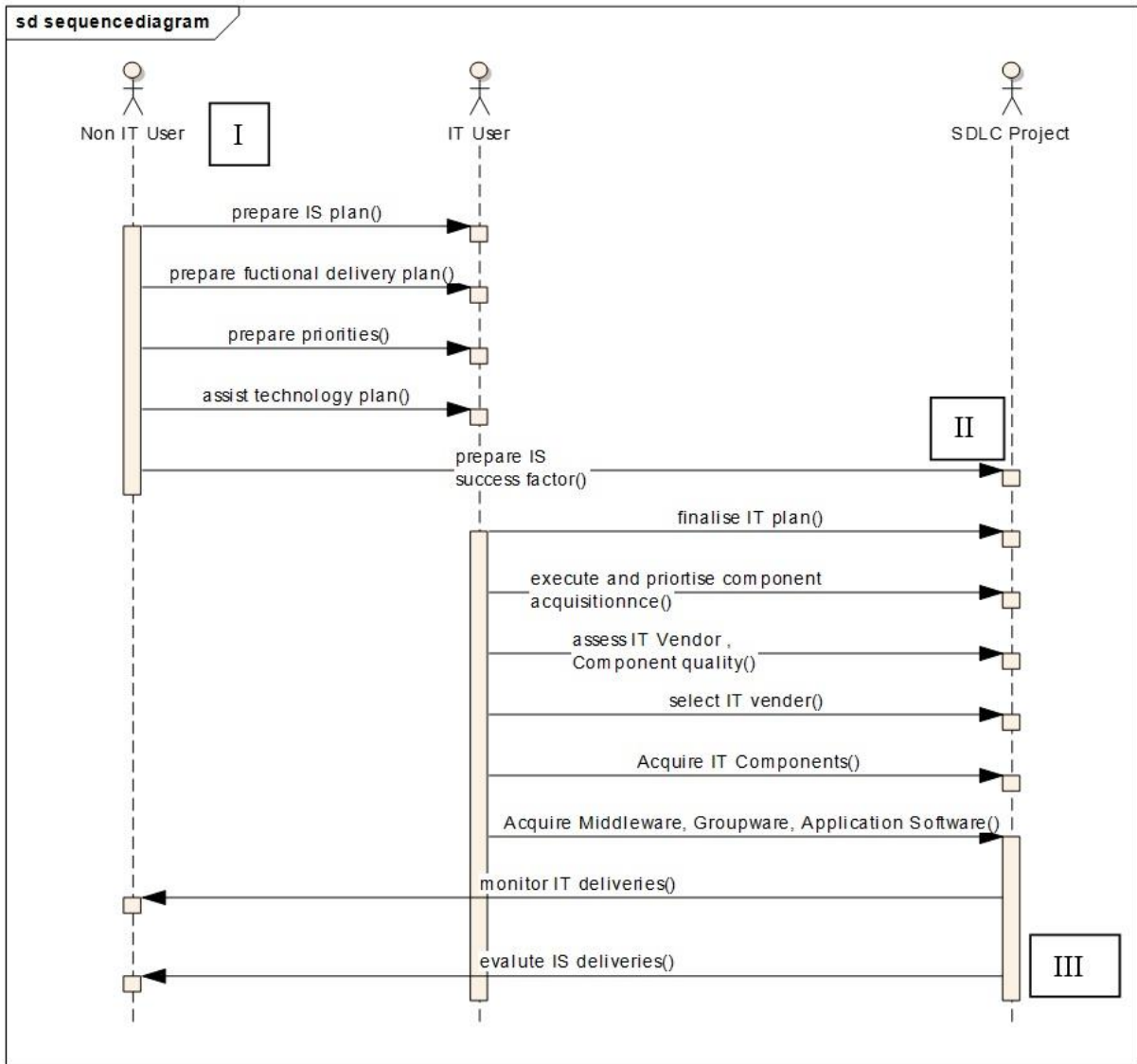


Figure 4: Sequence Diagram

In stage III, monitoring and evaluation of IS and IT deliveries are in the agenda since investments already made in stages I and II are to be measured vis-à-vis expected success factors. Actors defined here are “IT users”, “non-IT users”, and “SDLC projects” and all participate in the SDLC process.



- Capturing SDLC Behavioural Views: In this view business process diagram is used with “class diagrams” in which user capabilities are aggregated through individual non-IT and IT capabilities. Any change in the capability attributes would reflect in the overall capabilities in the organization and demand a change management exercise for corrective measures.

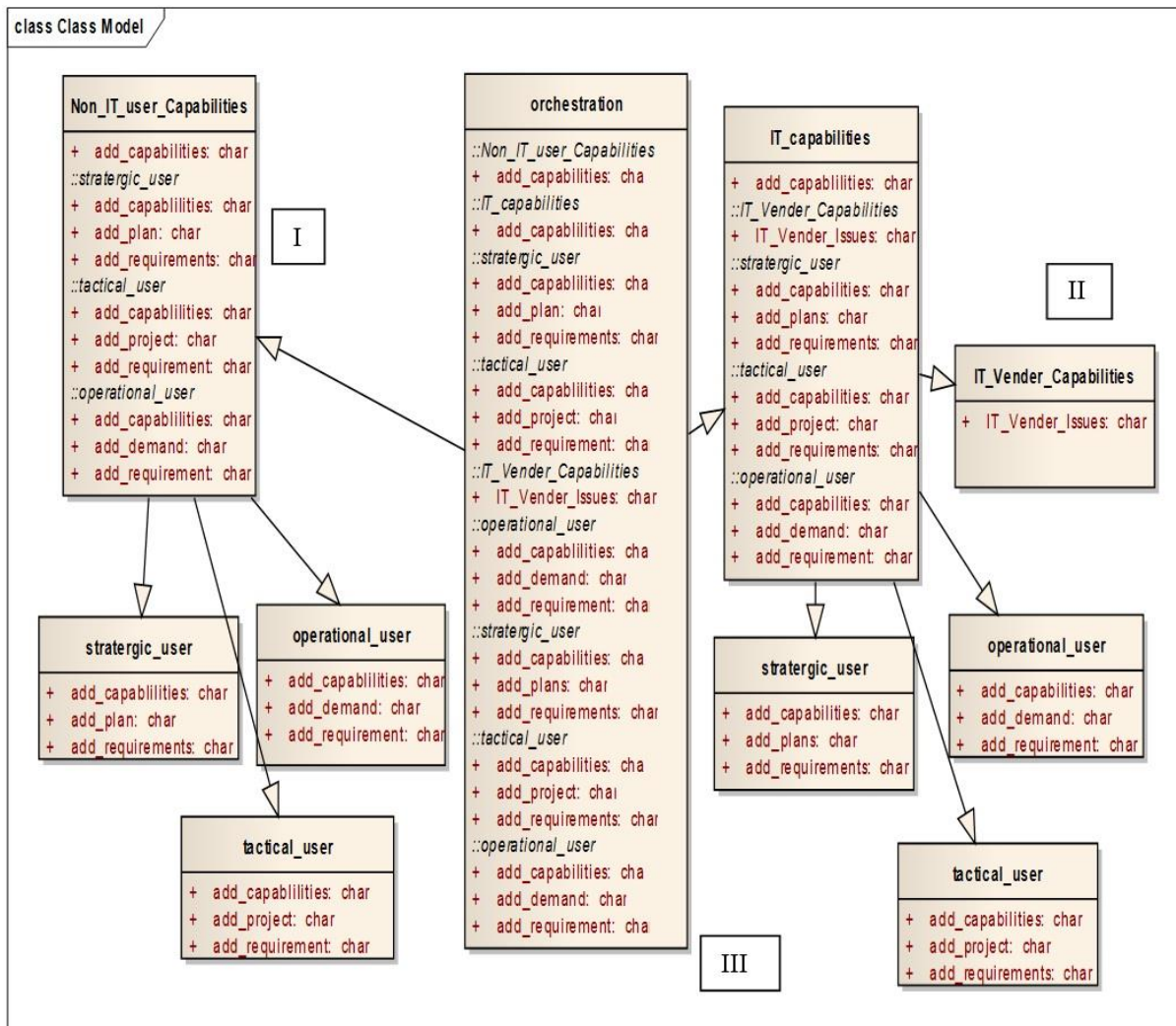


Figure 5: Class Diagram

In Figure 5 class diagram is explained. Stage I of the class diagram indicates non-IT user capabilities and these users form a class in the organization. IT users form another class and they collaborate with non-IT users to implement IS designed services. IT vendors also collaborate as another class to support the SDLC process. In stage II these activities are captured for mapping delivery issues. In stage III, an orchestration is necessary at organizational level to meet the business goals and mapping the capabilities of stages I and II.

**UML Based SDLC Process Modelling**

SDLC projects are part of organizational processes since they are expected to align IS with IT services as explained earlier. In Figure 5 the developed model reflects on the

behaviour of SDLC as discussed elsewhere. Behaviour of SDLC driven process model based on Figure 5 is developed through UML modelling exercise as presented in Figure 6.

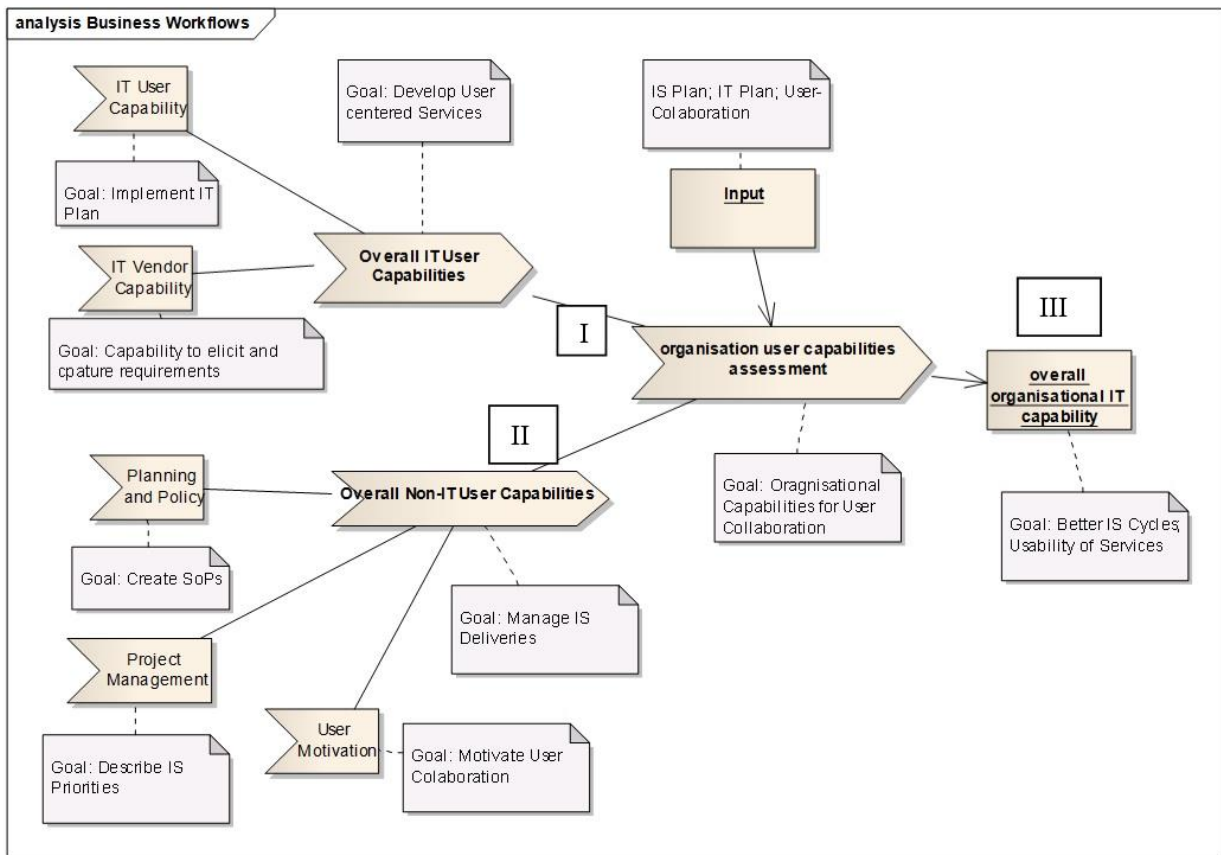


Figure 6: Process Diagram

In stage I processes are identified for non-IT capabilities with the goal of “managing IS deliveries” before the IT plan emerges. This is possible to track through identified goals of each sub-process like PP, PM, and UM as in Figure 5 and Table 3. Similarly, stage II covers the issues related to IT user capabilities with the goal “develop user centered services” (ITUC and ITVC) so that in stage III, the overall process (OUC) is managed with the goal of “having organizational IT capabilities”.

### Conclusion

SDLC projects are managed with a mandate to align IS with IT components. This exercise needs active collaboration of users at all levels in the organization. In this paper we state that identification of user capabilities is very important in the SDLC process and these are dynamic in nature. These capabilities need to be continuously assessed through a mechanism and thresholds are to be monitored for corrective measures. UML itself has many limitations in managing user capabilities. However, this modelling tool provides the organization an opportunity for motivating IT users and non-IT users to collaborate and contribute to agile application development and implementation processes. The UML driven model presented in this paper explains an approach to understand the capabilities of IT users and non-IT users to collaborate. Future work includes planning of capability thresholds,

examining the capability parameters, and preparing a decision tree to track incapability, and address them at the organizational level.

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