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Abstract

This study attempts to apply UML concepts to design UML diagrams that reflect the functional processes within the Client Tracking System (CTS) of a community service organisation. This paper represents Part I of a case study of the UML model for designing the CTS at the Learning Enrichment Foundation (LEF) in Toronto, Canada by Tran (2007). It investigates the task of constructing the design elements for CTS that can be used to manage the client information within LEF. Specifically, this paper investigates the system requirements in association with business and user needs, and use case diagrams of CTS. Furthermore, this investigation represents the UML model of the existing CTS at LEF. Through a study of how the CTS has been structured and how it operates, we may learn lessons that may be useful in other community networks serving significant immigrant communities.

Keywords

UML Model, System specification, Use case diagram, Client Tracking System, Business and use needs.

Background to the study

'*Paving the road to a brighter future*'. (LEF Annual Report 2005-2006)

Over its 25-year history, The Learning Enrichment Foundation (LEF) has become a leader in community social and economic development in the City of York. This area has received a high number of immigrants in recent years, and has been flagged as the part of Greater Toronto with the highest levels of poverty indicators. According to the LEF Executive Director, LEF has served between 6000 and 8000 clients. In particular over the years LEF has provided 'community-responsive programs and services which enable individuals to become valued contributors to their community's social and economic development' (LEF 2007a). Such services include job training, job search, counselling, recruitment services for the local community, and so on. The question is how LEF has achieved its mission successfully, and how it has met the needs of the local community in this disadvantaged part of Greater Toronto. Part of the answer lies in the Client Tracking System (CTS) used by LEF.

Through a study of how the CTS has been structured and how it operates, we may learn lessons that may be useful in other countries, such as Australia, New Zealand, Germany, etc. with significant immigrant communities served by community networks.

The CTS was developed within LEF and has been in operation since 1998. At the beginning this system was designed to support LEF in managing client information and contacting clients. Over the years, CTS has been upgraded to offer a job matching services to LEF clients. Presently, CTS provides a series of information services to the internal users within LEF and its partners, such as accessing client information, internal and external programs, staff information, program schedules, job matches, statistics and report generation, and so on. As the services have improved and increased, the CTS has accumulated more clients successfully.

This study attempts to apply UML concepts to design UML diagrams that reflect the functional processes within the CTS. This paper represents part I of a case study of the UML model for designing the Client Tracking System (CTS) by Tran (2007). It investigates the task of constructing the design elements for CTS that can be used to manage the client information within LEF. Specifically, this paper investigates the system requirements in association with business and user needs, and use case diagrams of CTS. Furthermore, this investigation represents the UML model of the existing CTS at LEF.

For organisations such as LEF, with limited funding, it is not possible to purchase a high-level system capable of delivering the services required. Conversely, a less expensive system that might be affordable generally cannot meet the requirements of LEF or similar organizations. Thus we are left with the development of workable

systems within these organizations by people who understand what the specific local needs are and what the system should do – the CTS is an example of just such a system.

Significance of the Study

Relying on Unified Modelling Language, this study provides useful knowledge and detailed discussion of the concepts of business modelling and use case diagrams. Such discussion can serve the interests of students, researchers, system designers and practitioners in software development and engineering. The use case diagram is one of essential steps for building a system based on UML. In summary, this case study attempts to achieve the following benefits and outcomes:

- It will contribute to our knowledge base in the fields of system design and UML diagrams.

- It demonstrates step-by-step practical diagramming for business modelling and use cases in system design.

- It contributes to the improvement of information and service delivery to local communities through an internal information system, such as the CTS at LEF.

- It increases awareness among system designers working in community organisations of the benefits and significance of system design. Such awareness can help these organisations become more responsive to their clients and stakeholders.

Methodology

This research employs a combination of methods to collect the best possible data and to understand the meaning of the data as clearly as possible.

- It begins with a review of the literature on UML models plus initial fieldwork involving visits to LEF in order to gain an understanding of the organisation, its activities and services. Additionally, such visits allow the researcher to observe the development and use of the existing CTS within LEF. This initial step is the grounding for the research – a combination of literature review and collection of observational data on the development of CTS. It should be noted note that description of the existing CTS is partly dependent on a number of unpublished resources within LEF.

- The next step is to communicate (verbally and by email) with the managers and system designer, who have been involved with the development and implementation of the CTS, for their explanations and clarification about what is observed.

- In the final step the research, based on the preceding analysis, designs a series of detailed UML diagrams in order to derive a design model of CTS based on the existing literature in the field of UML models for system design.

Research Objectives and Research Questions

This research is undertaken to fill a gap in our knowledge of system design for community services within community organisations, and to further our understanding of the association between system requirements and business and user requirements through design processes. To achieve this aim the research is designed in two parts. The first part focuses on observation of the existing CTS within LEF. It explores the users, components, structure and operation of the system for tracking client information and making job matches. The second part analyses and develops use case diagrams for designing the CTS. In addition this part also discusses the outcomes of the CTS in relation to business and user requirements.

To focus this investigation, the key issues can be stated as two research questions:

- What are the system requirements based on business and user needs of CTS?

- What use case diagrams, as part of the UML model, make up a client information system that can support LEF in meeting the needs of its clients in the local community?

Definitions of Terms

Cooper and Schindler (1998) state that confusion about the meaning of concepts and key terms can destroy a study's value without the researcher or client even knowing it. 'If words have different meanings to the parties involved, then they are not communicating on the same wavelength. Definitions are one way to reduce this danger' (Cooper and Schindler 1998, p. 38). In order to analyse and discuss the design model of CTS the following terms require definition: 'UML model', 'design model', 'client information', 'client tracking system',

'business requirements', 'user requirements, 'system requirements' and 'community services'. These terms are used frequently through out this research paper.

Unified Modelling Language (UML) is used for object modelling in designing software or application programs. UML 'includes a graphical notation used to create an abstract model of a system, referred to as a *UML model*' (WikiPedia 2007). The *UML tool* allows software designers to draw use cases and design system diagrams, such as class, object, sequence, activity, state, collaboration, and component and deployment diagrams. The concepts of each diagram will be explained in Section 5.7.

Design model of a computerised system describes a sequential process that begins with the analysis of system requirements, followed by a collection of specific diagrams for depicting system structure, its components and operation; it ends with the deployment diagram to achieve system requirements.

Client information contains client demographic characteristics, such as gender, age, employment history, education, etc. Such characteristics allow LEF staff to provide relevant community services to their clients.

Client Tracking System is a computerised system employed by internal users within an organisation for storing and managing client information, for searching job matches, and for sharing information between the organisation and its partners.

Business requirements for developing a computerised system should be considered essential to success, because the technical and functional approaches of the system are based on such requirements. 'If requirements are incorrect, incomplete or ambiguous, the solution [of a system] will be flawed and is likely to exceed both the budget and the schedule' (Software Architects 2005). Business requirement is defined as 'a high-level definition of the system for functional and non-functional components' of the system, such as performance requirements, usability requirements, logistic requirements, personnel requirements, and training and documentation requirements. This research uses 'business requirements' to cover the needs and challenges of partners, collaborative organisations, agencies, public foundations and private donors, etc. These needs and challenges are associated with the delivery of community services by LEF, such as training programmes, client recruitment, employment services and sharing client information.

User requirements for developing a computerised system involves preparing '…for writing an accurate and complete Statement of Work. The Statement of Work is a key element of the Software Contract Package' (EPRI 2007). Therefore, the user requirements should be well-specified at the beginning of a software project, and they should be consistent with business requirements. As a result, user satisfaction when using the software should be higher. This research defines 'user requirements' as the user needs expressed as specific functions and activities that the internal users want the system to facilitate within an organisation. These needs are associated with the management of client information and the delivery of relevant community services that LEF has committed to providing for the local community, such as training programmes, client recruitment, employment services and sharing client information.

System requirements are defined as the specification of possible structures, required contents, and functions in detail of a system. A system requirement specification (SRS) is a completed description of the system behaviour, including 'a set of use cases that describe all of the interactions that the users will have with the software. Use cases are also known as functional requirements' (WikiPedia 2007). Additionally, a SRS may include nonfunctional (or supplementary) requirements. These requirements impose constraints on the design or implementation of the system (such as performance requirements, quality standards or design constraints). In addition these requirements should be consistent with business and user requirements.

This case study has investigated a set of nine UML diagrams for the Client Tracking System. Each diagram was designed to support the system designers and developers, to help customers in observing a software system from various perspectives, and to improve their understanding of cohesion and abstraction in designing a system or software.

Statement of the Modelled System – CTS

> The purpose of the CTS will be to facilitate the internal management of clients within an organization (Operations Module), and enable the sharing of client information and cross-referral between members of the collaborative (Referral Module). (LEF 2006, p. 12)

This case study explores the tasks involved in creating the design elements for the CTS that can be used to manage clients within LEF. According to the Executive Director, LEF provides over 300 graduates each year with specific job skills and practical experience that employers require (LEF 2007b). LEF has offered a variety of training programs to its clients, such as early childhood assistance, industrial skills, budgeting workshops, IT project management, enhanced language training and cookery training. There are some user groups within LEF

who expect to use the client information in CTS to design and manage training programs for their clients. Such users include organisational managers and directors, program managers, counsellors and administrators.

Specifying System Requirements Based on Business and User Needs

This section explores system requirements based on the specifications of business and user needs of LEF and its partners. According to LEF's report on the development of CTS (LEF 2006), there were six categories of business requirements in association with the creation of CTS (see below). These requirements were the foundation of the specification of user needs. Relying on such business and user needs, system requirements are then defined consistently. Specifically, this section specifies the functional activities of CTS in association with business and user needs. This is an initial step prior to approaching the specification of user cases of CTS.

LEF aims to provide community and training services for a generally underprivileged region of Toronto. It is believed that in order to provide relevant job training, job matches, childcare, etc. LEF staff should have such client information as employment history, education, expectations and needs, etc. Failure to have such client information, and to be able to locate it quickly, would lead to an inability of LEF employees to provide relevant community and training services to their clients. Conversely, LEF would be successful in providing services to its clients if the employees had accurate and current information of their clients.

The key question, then, is how LEF can provide accurate and current client information to its employees. This depends on the implementation of an internal system that can provide access to client information within LEF.

Therefore, in order to deliver quality training and other programming to clients, LEF and its collaborative members faced a challenge in facilitating information management of client data. There was an urgent need to develop an information system for managing clients. Such a system was termed 'Client Tracking System' or 'CTS'. Regarding the operating criteria, it was stated that the CTS should meet the following organisational needs (LEF 2006):

- Precise and comprehensive client recruitment, screening and placement

- Clear and efficient program design and delivery

- Timely and accurate management of funding streams

- Access and referral to external training opportunities

- Quick and professional service delivery

- Specialisation and development of expertise.

The following sections (1.1-1.6) are based on statements in LEF's unpublished report, Report on Client Tracking System: Business Requirements (2006).

1.1 Precise and Comprehensive Client Recruitment, Screening and Placement

Business need - LEF and its partners must have access to accurate client information, such as personal data, employment and case histories in order to design effective programs, referrals and targeted funding requests.

User need - LEF staff should be able to manage, record, sort and screen client information in order to achieve greater levels of accuracy and security while allowing for increased flexibility in data management.

System requirement - CTS should allow the users to do the following:

    - Input and save client data

    - Sort client data flexibly

    - Edit and amend client data

    - Create client interview templates

    - Assign clients to training programs.

1.2 Clear and Efficient Program Design and Delivery

Business need - LEF and its partners share a focus on effective program delivery. They must be able to change and adapt to trends and opportunities on time as they are identified in order to leveraging internal resources and adapting to the funding environment.

User need - LEF program managers should be able to design and edit multiple programs to accommodate changes in client needs and funding streams for ensuring consistent quality in service to clients.

System requirement - CTS should allow users to do the following:

- Create program process models and frameworks, including registration criteria, interview processes and reporting requirements

- Assign instructors to programs

- Browse and edit lists of available programs

- View and book classrooms and schedule resources.

1.3 Timely and Accurate Management of Funding Streams

Business need - Regarding funding issues, LEF partners, government, public foundations and private donors have unique reporting requirements. These requirements become a resource-intensive and potentially burdensome obligation that can be allocated to service delivery to clients.

User need - LEF program managers should be able to track client progress, manage and allocate multiple funding streams, produce statistics and generate customised reports for the partner organisations.

System requirement - CTS should allow users to do the following:

- Track and allocate existing funding streams to ensure effective and comprehensive use

- Generate statistical information for program development

- Design report templates

- Generate and submit reports to funding agencies.

1.4 Access and Referral to External Training Opportunities

Business need - Counsellors must access to a comprehensive listing of available training programs in order to explore the opportunities to serve its clients among partners and collaborative organisations.

User need - LEF Counsellors should be able: 1) to view program opportunities in partner organisations, compare client information with eligibility criteria and enrol clients directly in programs within partner organisations, and 2) to track client performance and share notes where appropriate.

System requirement - CTS should allow users to do the following:

- View list of program opportunities available within partner organisations

- Promote new program opportunities to partner organisations

- Receive and process inquiries

- Register clients in external programs.

1.5 Quick and Professional Service Delivery

Business need - LEF and its partners must provide timely and effectively service to their clients. Specifically, they should serve the needs of their clients quickly and efficiently, and should reduce attrition and duplication of resources between organisations.

User need - LEF staff must be able to register a new client quickly and provide LEF managers and partners with information on streamlining internal intake processes of existing clients, and available training programs.

System requirement - CTS should allow users to do the following:

- Process and record client data during initial interview

- Register clients in external programs

- Provide detailed schedules and intervention plans to clients early (if not immediately) in the intake process

- Maintain and access accurate and up-to-date client files and counsellor notes.

1.6 Specialisation and Development of Expertise

Business need - LEF and its partners must share a commitment to the effective use of public and foundation funding in order to develop new programs based on existing strengths or underserved needs of their clients.

User need - LEF staff should be able to make existing information available for review by establishing, through the required management structure, a framework for dialogue and exchange.

System requirement - CTS should allow users to do the following:

- Access lists of available programming in partner organisations

- Generate comparative statistics on program success rates

- Track program performance and client job placement rates

- Create program templates for new initiatives.

Hironaka (1999) states that the main purpose of system requirements is to identify the needs and constraints that the system being developed will satisfy. Specifically, system requirements should include: the system's functional requirements, quality attribute requirements, system interface requirements, data requirements. The CTS is designed for managing client information to serve the internal users within LEF. Therefore, the requirements of this system should accommodate the business and user needs as described above.

Use Case Diagrams

The use case diagram is used to identify the primary elements and processes that form the system. The primary elements are termed as 'actors' and the processes are called "use cases." The Use case diagram shows which actors interact with each use case (Chitnis, Tiwari & Ananthamurthy 2002).

Relying on the business and user needs and system requirements stated in the previous section, this section attempts to apply UML concepts to design use case diagrams of CTS.

• *Actors* - any entities, things, objects or individuals that perform certain roles within the modelled system.	
• *Use cases* - every use case provides one or more narratives that describe expected interactions between the actors and the modelled system in order to achieve a distinct business functionality. Such functionalities are represented by use cases in the modelled system.	

A use case diagram depicts the functional roles of a system. Such a diagram should describe the business processes carried out by the system and describe the system requirements that are being modelled. As a result, use case diagrams describe the relationships between actors and use cases within a system.

Identifying Actors of CTS

Use case modelling of CTS involves the analysis of business requirements of the system. Relying on the two LEF reports on the CTS (LEF 2005 & LEF 2006) and the statement of the modelled system above, there are four groups of users who are specified as actors of CTS:

- *Organisational managers* - who use CTS to support their tasks in designing programs, fundraising and making reports.

- *Program managers* - who use CTS to support their responsibilities in allocating funding resources, identifying logistical requirements, and processing statistical and other information necessary to support the organizational managers.

- *Counsellors* - include the frontline workers who use CTS to support their responsibilities in interacting with, and delivering services to, clients. This includes registrars, employment counsellors and language trainers.

- *Administrators* - include the technical staff who use the CTS for customising and managing the CTS itself and its inter-organisational functionality.

Identifying Use Cases of CTS

Regarding the statement of the modelled system and the specification of system requirements in the previous sections, the 11 use cases must be contained in the CTS (see Figure 1). In particular, different actors have different relationships in association with each of use cases.

There are similar relationships between the actors and the three use cases - *View employers, View contacts,* and *View external programs.* The counsellors should be able to input employers, contact information, and external programs and opportunities into the database; then the organisational and program managers will be able to access and view such information for their specific purposes.

Provide internal programs - this use case allows program managers to create programs and frameworks (such as registration criteria, interview processes, reporting requirements, assigning instructors to programs) and input them into the database, while counsellors can access such internal programs for assigning relevant clients. Meanwhile, the organisational managers can access such programs for making reports or generating statistical information for program development.

View jobs and positions - this use case allows counsellors to input the available jobs and positions into the database; then both organisational managers and program managers are able to access and view such jobs for various purposes.

Generate reports - this use case allows the organisational and program managers to create and customise templates of reports, generate data, information and statistics within the system for reporting requirements, and print out reports.

Manage clients - this is one of the most essential use cases for CTS and most system requirements. 'Clients' are the central core that CTS aims to serve, and most other use cases within CTS aim to support the clients. Therefore, this use case should allow counsellors to manage client information. Specifically, counsellors should be able to record, sort, edit, update, manipulate and maintain client information within the database. Then the organisational and program managers will be able to access, view, browse and use client information for various purposes.

Provide schedules - this use case allows counsellors to provide detailed schedules and intervention plans to clients early in the intake process. Then the organisational and program managers can access such schedules and plan for various purposes.

Search for job matches - this is another essential use case of the system. It allows counsellors to find job matches for a specific client based on his/her qualifications, experience and skills. The organisational and program managers can browse results of job matches according to names, languages, qualifications, employment history, etc. for reporting requirements, or designing training programs and opportunities.

Staff login - This use case should allow the administrator to assign users their IDs and passwords to enable them to log in to the system. All counsellors, organisational and program managers will be able to log in to the CTS using a specific ID and a secure password.

View staff - every actor within the system has an equal relationship in this use case. The administrator, counsellors, organisational managers and program managers should be able to browse for internal staff and view and modify their personal information.

View database - This use case should allow the counsellors to input data and to manage the database, and the administrator,   organisational   and   program   managers   to   access   and   view   the   database.

Figure 1 represents the use case diagram of the CTS including all the actors and use cases in association with system requirements. Relying on the LEF report on CTS (LEF 2005), this diagram shows:

- the operation module of CTS that supports the organisational and program managers and counsellors in managing and using client information, designing and implementing program opportunities and allocating and reporting funding streams; and

- the referral module of CTS that supports counsellors in assigning training, and searching job matches and service opportunities, managing the external requests for employment opportunities, and offering specialised opportunities to the external organisations and partners.
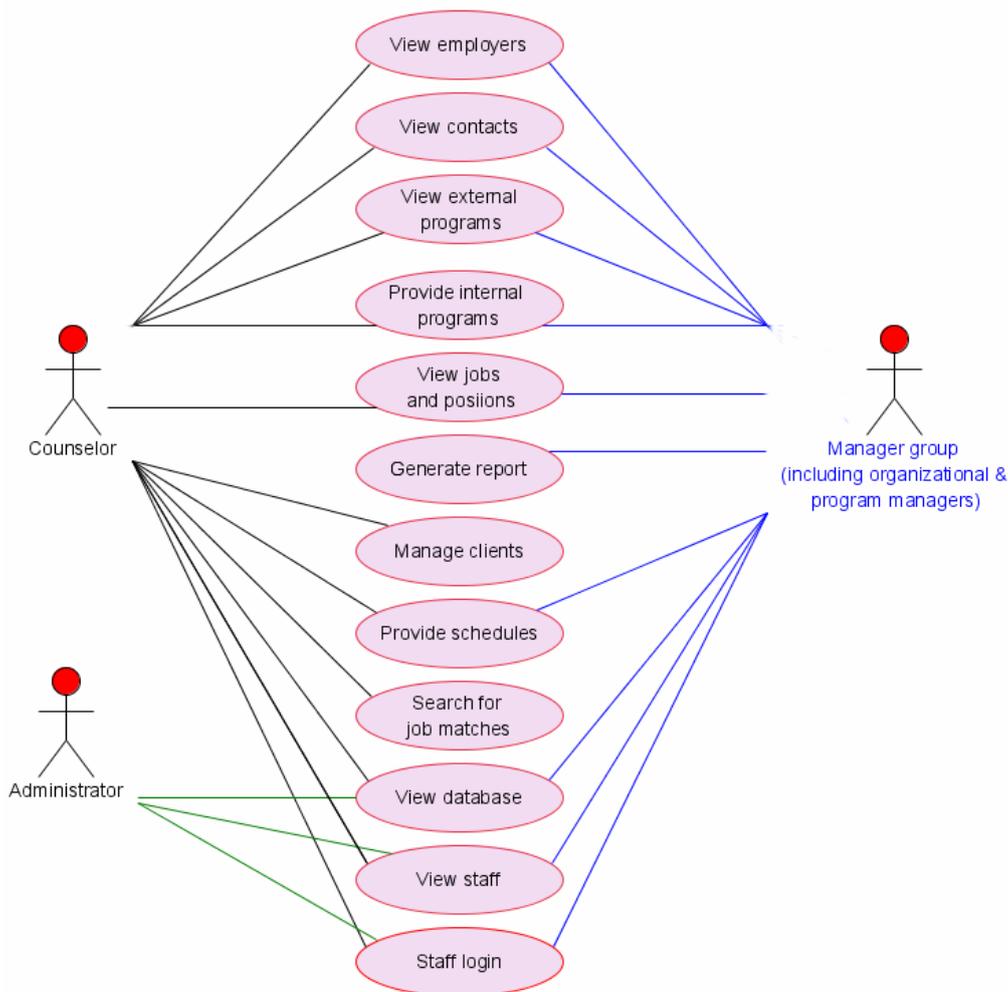
Figure 1: Use Case Diagram for the CTS

UML Model of CTS

It is very important to distinguish between the UML model and the set of diagrams of a system. A diagram is a partial graphical representation of a system's model. The model also contains a "semantic backplane" - documentation such as written use cases that drive the model elements and diagrams (WikiPedia 2007).

The UML model of the CTS in this case study can be considered an organised collection of diagrams carried out through CTS implementation. UML is used for modelling a system because it is a standard language for designing detailed diagrams at different points of time in the software life cycle of a system. Such diagrams can be used on an incremental basis as the need arises of a system (Chitnis, Tiwari & Ananthamurthy 2002).

Based on the analysis of system specifications and the creation of use case diagrams as above, and a set of further UML diagrams in Tran (2007), we have devised a UML model for designing the CTS that contains four parts. These parts can be visualised in Figure 2, and are summarised as follows:

Functional model - This part describes the system specifications. It analyses the essential requirements around which the system has been built. Such requirements include the business needs and user requirements, and the specification of system requirements as discussed in the previous section. The use case diagram (Figure 1) depicts essential actors and use cases that can meet the functionalities of the modelled system in association with business and user needs, and system requirements.

Structural model - This part describes the way that system should look. It analyses the structure and substructure of the modelled system based on objects, attributes, operations and relationships. The class diagram depicts the structure of CTS by representing a series of system classes, their attributes and the associations among classes. Additionally, the object diagrams also represent the structural aspects of the CTS.

Dynamic model - This part describes the way that the system should work. It analyses the system behaviour, including sequence and communication diagrams, activity diagram, and state diagram.

Implementation model - This part describes the way that the system should be deployed. It integrates Parts 1-3 to depict the implementation of CTS. The component and deployment diagrams show the integration of system components and the interactions among them for deploying the modelled system.
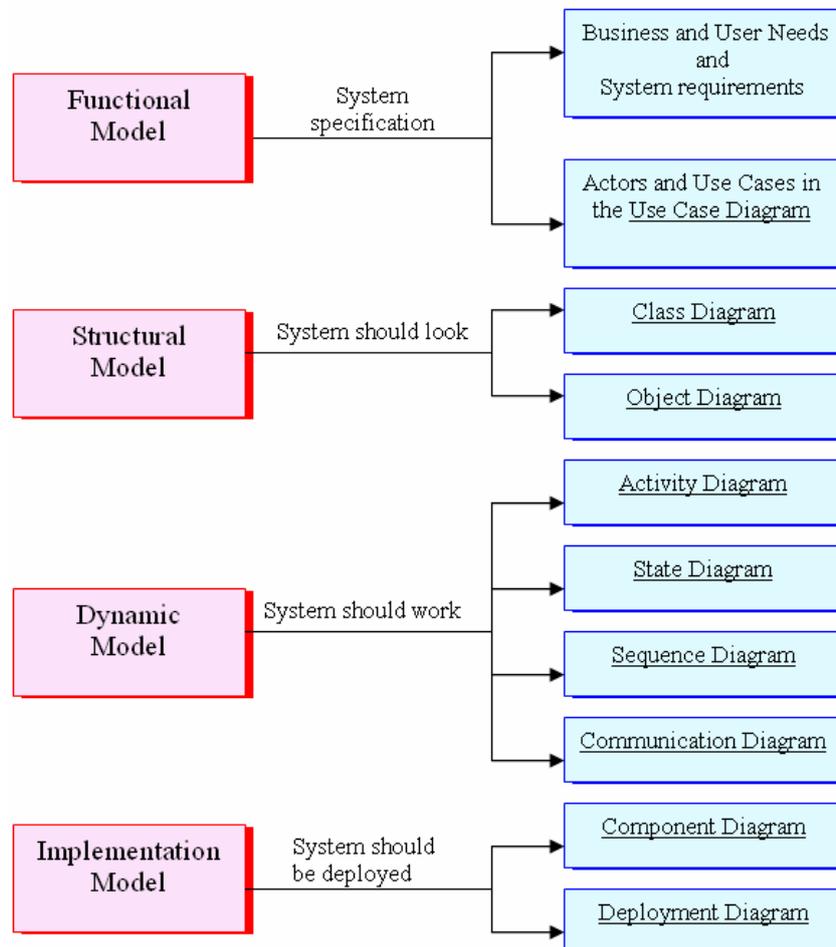

Figure 2: UML Model of Client Tracking System

Conclusion

This case study has investigated system requirements, use case diagrams and the UML model for the Client Tracking System. Such diagrams were designed to support the system designers and developers, to help customers in observing a software system from various perspectives, and to improve their understanding of cohesion and abstraction in designing a system or software.

This case study provides an in-depth technical study of business, user and system requirements with use cases for CTS. Diagramming techniques are based on the Unified Modelling Language (UML) v2.0. The requirements produced are sufficiently detailed to form the basis for the development of an information system using both the practical analysis of use cases and the conceptual model for UML. The analysis of business and user needs, system requirements, and use cases are essential steps for building a system based on Unified Modelling Language. According to LEF Reports for 2005 and 2006, the CTS has been shown to serve as a powerful tool for internal users in managing their clients, supporting them, providing them with relevant training and programs, and job matching services in particular.

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