Principal – Agent theory approach for determination of appropriate 'Activity Model' for cadastral information updating in Nepal

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Abstract

In Nepal due to the increased need of agricultural based economical activities and rural to urban transactions process there is a need of reliable and ready access to cadastral information. The Ministry of Land Reform and Management (MoLRM) has targeted to develop nationwide LIS for updating and dissemination of reliable and accurate land information. A LIS consists of two databases an administrative/legal system i.e. attribute data and a digital cadastral map i.e. spatial data containing the ownership, value and use of land. The Department of Land Information and Archive (DoLIA) has started developing district wise LIS. This approach needs much more resources in comparison to the centralized LIS. From financial perspective the updating of cadastral information is much more expensive than the land registry information. So, there is a need of determination of appropriate "Activity Model" for cadastral information updating process.

This research paper provides an approach for determination of appropriate 'Activity Model' for cadastral information updating in Nepal. The Principal - Agent (P-A) theory approach has been used for the determination of appropriate 'Activity Model'. Six different options according to the P-A relationships were evaluated with twenty institutional and technical parameters and found that CC (central authority and central activity) is optimal for cadastral information updating procedure. Eight different processes for the cadastral information updating are identified and modeled them using object oriented modeling techniques with UML activity diagram. Two ways of verification has been used to test the model. The model is conceptually tested developing use cases with the help of activity diagram. The feasibility of the model is tested using Arc cadastre software with the direct link to geo-database.

Introduction

The high level political objective of Nepal is poverty reduction. Appropriate Land Reform and Management strategies could be one of the means to reduce the poverty. The major objectives in the Land Reform and Management sector are to ensure sustainable land use and management, update and maintain land records/information, and increase access of the poor to land resources and ensure effective utilization through enhancement of their skills [6]. In order to meet the above mentioned objectives land information system (LIS) would be a viable and inevitable system. A LIS consists; on the one hand, of databases containing spatially referenced land-related data for a defined area and, on the other, of procedures and techniques for the systematic collection, updating, processing and distribution of the data [5]. The usefulness of LIS depends upon up-to-date ness, accuracy, completeness and accessibility, and upon the extent to which the system is organized for the benefit of the user rather than that for the producer.

In Nepal, the Ministry of Land Reform and Management (MoLRM) is mandated for the tasks related to Land Administration (LA). Under this Ministry, Department of Survey (DoS) and Department of Land Reform and Management (DoLRM) are responsible for the tasks of cadastre and land registration. Both the Departments maintain land records (cadastral maps and ownership records) at their district offices. Under the same ministry Department of Land Information and Archives (DoLIA) is responsible for building a nation-wide LIS. Besides this, the Trust Corporation is responsible to handle the administration of Trust land. Within the district, the local authorities such as Municipalities and Village Development Committee (VDC's) are responsible for the land taxation

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and mainly dependent on data and services provided by the district survey and land registry offices. The Land Management Training Centre is responsible for the human resource development in the sector of land registry and cadastre. The Ministry of Land Reform and Management (MoLRM) has targeted to develop nationwide LIS for updating and dissemination of reliable and accurate land information. A LIS consists of two databases an administrative/legal system i.e. attributes data and a digital cadastral map i.e. spatial data containing the ownership, value and use of land. The Department of Land Information and Archive (DoLIA) has started developing district wise LIS. This approach needs much more resources in comparison to the centralized LIS. More over, from financial perspective the updating of cadastral information (CI) is much more expensive than the land registry information.

This research paper provides an approach for determination of appropriate ''Activity Model'' for cadastral information updating in Nepal. The Principal - Agent (P-A) theory approach has been used for the determination of appropriate ''Activity Model''. Six different options according to the P-A relationships were identified and evaluated with twenty different parameters and found that CC (central authority and central activity) is optimal for cadastral information updating procedure. Eight different work processes for the cadastral information updating are identified and modeled them using object oriented (oo) modeling techniques with UML activity diagram. Two ways of verification has been used to test the model. The model is conceptually tested developing use cases with the help of activity diagram and physically using Arc cadastre software with the direct link to geo-database.

Institutional and Technical Parameters

According to Radwan and Bishr, [7] Geographical Information Infrastructure (GII) has mainly two components; institutional and technical. Bogaerts [1] emphasizes five aspects that are crucial for a well functioning cadastral system; political aspects, legal aspects, organizational aspects, financial aspects and technology. He has formulated some critical success factors about these five aspects. The most critical success factors for cadastral system are legislation, organization, financing, data and its quality, technology used and human resources. Among these, organization and management are the most critical in the context of the Phare countries [2]. Likewise, Steudler [8] has defined five evaluation areas; Policy level, Management level, Operational level, External factors and Review process, and formulated some evaluation aspects and good practice for the evaluation of land administration system. Likewise, Tuladhar [9] suggests the following eight critical success factors (CSFs) for the implementation of Parcel Based Geographical Information System (PBGIS).

- Institutional support, including political support
- Legal
- Financial
- Organization including co-ordination and co-operation
- Management including market orientation and information requirement
- Technical including system development, system installation infrastructure establishment and maintenance
- Standard
- Quality Management

Incorporating all these literatures for the determination of appropriate 'Activity Model', two aspects institutional/ organizational and technical are considered and the parameters are formulated for the evaluation based on these two aspects. Twelve institutional parameters and eight technical parameters are formulated based on the literature study and local expert's consultation for the determination of appropriate 'Activity Model'. The Twelve institutional parameters and eight technical parameters are tabulated in Table 1.

Institutional and Technical Parameters for evaluation of CI Updating

Institutional Parameters	Technical Parameters
1) Land Policy	1) Physical Infrastructure
2) Resources	2) ICT Support
3) Cost	3) Market Adaptation
4) Stakeholders Interest	4) Technical Expertise
5) Political Interest	5) SDI Support
6) WF Management	6) Data Security
7) Cultural Aspect	7) Data Management
8) Co-ordination and Participation	8) Quality Management
9) Customer Satisfaction	
10) Funding Agency's Interest	
11) Process Time	
12) International Declaration	

Table 1: Institutional and technical parameters for evaluation of CI updating process

Principal – Agent (P-A) Theory Approach

The method used here for the determination of appropriate 'Activity Model' for cadastral information (CI) updating is Principal-Agent (P-A) theory approach. According to de Vries [4] the neo-institutional economics (NEI) has various perspectives like Property Right Theory, Transaction Cost Theory, Principal-Agent (P-A) Theory and Bureaucracy Theory. The P-A theory focuses on authority and sharing of responsibilities. In P-A relationships there are three aspects to be considered. The first aspect is the definition of who has authority/ responsibility (principal) and who is carrying out on behalf of authority (agent), the second aspect is to which extent can principal control/check agent and the third is to which extent agent can achieve authority / responsibility. Based on this, basic concept of P-A relationship for cadastral information updating, the following idea has been generated.

Who is principal and who is agent?

There are four different organizations involving for CI updating process; Centre Office, District Office, Private Sectors and Local Authority. According to P-A relationship the principal could be either Centre Office or District Office; the activities could be done by Centre Office, District Office or Private Sectors.

To which extent can principal control/ check the agent?

The most important thing in the P-A relationship is to know exactly who is controlling to whom and to which extent they are controlling [3]. For the optimal P-A relationship, there should be limited power delegated to the agent. In some extent the principal should control/ check the agent such that the total agency cost is optimal.

To Which extent can agents achieve authority / responsibility?

The most important thing in the P-A relationship is to determine which activities should be outsourced to the agent and up to which extent. In the cadastral information updating process, some of the activities should be outsourced. For example, some of the activities of district cadastral office like scanning and digitization of cadastral map, field works etc. could be outsourced to the private sector. Hence, it should be made out in advance that which activities should be given to the private sector and how to control the quality of work carried out by the private sector

From the basic principal of P-A theory, there are six different options; CC, CL, CP, LC, LL and LP (Table 2) for CI updating process.

Activities / Authority	Central	Local	Private
Central	CC	CL	CP
Local	LC	LL	LP

Table 2. Six possible scenarios on the basis of P-A relationship

A brief description of these six possible scenarios on the basis of P-A relationship is given as below.

CC: In CC, both the activity and authority remain at central level.
CL: In CL, the authority remains at central level and the activity at local level.
CP: In CP, the authority remains at central level and the activity at private sector.
LC: In LC, the authority remains at local level and the activity at central level.
LL: In LL, both the authority and activity remain at local level.
LP: In LP, the authority remains at local level and the activity at private sector.

Evaluation of Six Different Options According to P-A Relationship

According to the table 2, there are six different options incorporating P- A relationship approach. An evaluation table was formed as parameters in the rows and six options in the columns and for each of the parameter the best option has been marked with a tick. In the beginning the best option for each of the parameter was selected by literature review and author's own experience. Later, the same table was distributed to the local experts for the verification and their feedback was incorporated. The result f findings has been shown in the table 3 below.

Parameters		CC	CL	CP	LC	LL	LP	NA
Institutional	1) Land Policy							√
	2) Resources	?						
	3) Cost	?						
	4) Stakeholders Interest					?		
	5) WF Management	?						
	6) Political Interest							?
	7) Donor Interest							?
	8) Customer Satisfaction					?		
	9) Cultural Aspect					?		
	10) Co-ordination and Participation					?		
	11) Process time		?					
	12) International Declaration							?
Technical	1) Physical Infrastructure	?						
	2) ICT Support	?						
	3) Market Adaptation	?						
	4) Technical Expertise			?				
	5) SDI Support		?					
	6) Data Security		?					
	7) Data Management	?						
	8) Quality Management					?		
	Total	7	3	1	0	5	0	4

Table 3: Evaluation of six different options according to the P-A relationship

In Nepal, the Land Policy is not formulated yet, as a result it can not be evaluated what option would be appropriate for the CI updating according to the P-A relationship. Politicians do not have any interest on the updating mechanism, as this is the organizational matter. Donors or funding agencies work on the basis of how they are approached. International declarations do not impose any compulsory mechanism to be followed for cadastral information updating. On the basis of these facts, the institutional parameters; land policy, political interest; donor interest and international declaration do not have any implications about the options about cadastral information updating. The institutional parameters like resources, cost, WF management favors for the Central Activity Central Authority (CC). But the parameters like stakeholders interest, customers satisfaction, cultural aspect and co-ordination and participation favors for the Local Authority Local Activity (LL).

The availability of Physical infrastructure, ICT support, and technical expertise are superior in the central office. The availability of the components of market adaptation is more in the centre. The availability of data at one place makes easier for data management. Hence the technical parameters like physical infrastructure, ICT support, market adaptation and data management favors the Central Authority Central Activity (CC) option. Likewise, the technical expertises are more in the private sector so it favors for the Central Authority Private Activity (CP). The Local Activity (CI recording and processing) and Central Authority makes the SDI support and more data secured hence SDI support favors CL. Likewise, the option Local Authority Local Activity (LL) favors for the quality management.

For the Multi Criteria Analysis (MCA), the weight of each of the parameter is assumed equal and it can be concluded from the evaluation result that the option Central Authority Central Activity has got the maximum weight i.e. seven. From the analysis it can be concluded that the option CC is optimal incorporating the P-A relationship.

Appropriate 'Activity Model' by Incorporating P-A Relationship Approach

From the above evaluation the option CC is the optimal according to the P-A relationship approach. For the determination of appropriate 'Activity Model', also, the same P-A relationships approach has been adopted. The first aspect in P-A relationship approach is identification of who has authority/ responsibility (principal) and who is carrying out on behalf of authority (agent). There are four organizations, central office, private sectors, district office and local authority involving for the CI updating process. The central office and district office is the principal and private sectors and local authorities are the agent for the centralized CI updating process. The second aspect of P-A relationship approach is to determine which extent can principal control/check the agent and the third aspect is to which extent agent can achieve authority / responsibility. Considering this second and third aspect of P-A relationship the activities done by each of the organization has been determined. The appropriate 'Activity Model' incorporating P-A relationship has been shown in the Fig. 1.

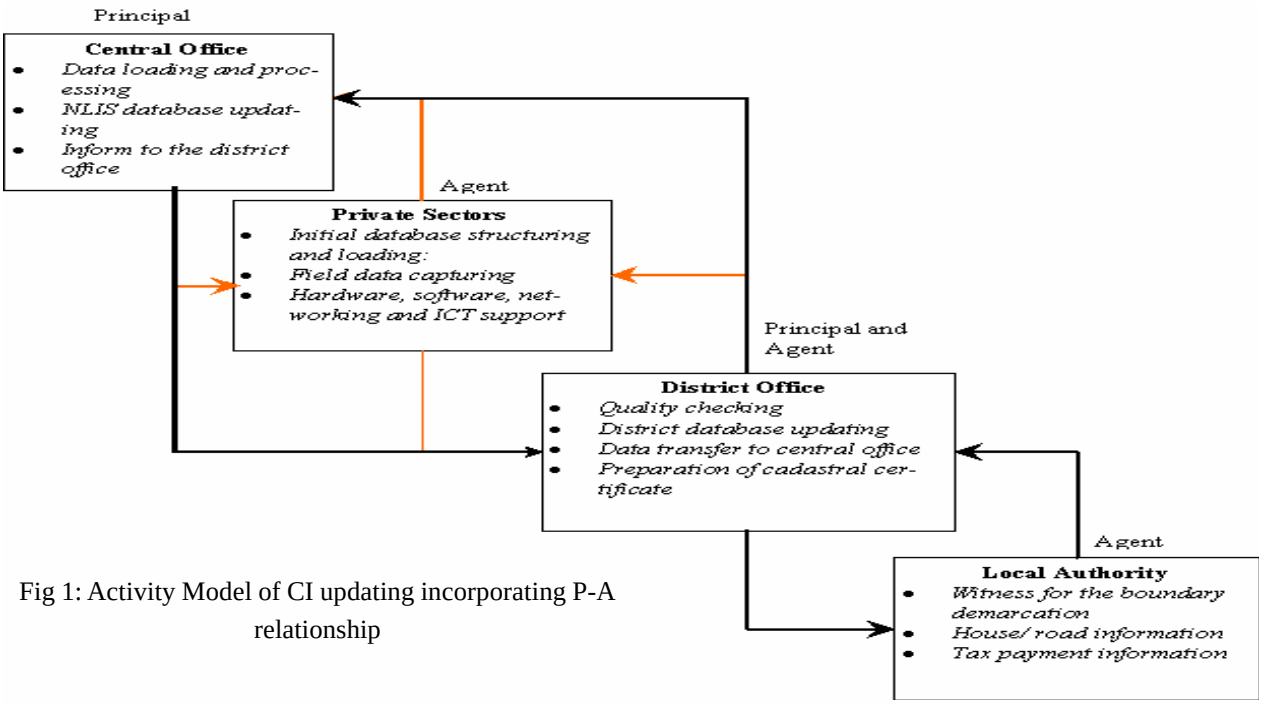

Fig 1: Activity Model of CI updating incorporating P-A relationship

The Central Office could be the principal for CI updating. The main activities of Central Office are data loading and processing, NLIS database updating, inform to the District Office. The Private Sectors are the agent and their main activities are initial database structuring and loading, field data capturing, support for hardware, software, networking and ICT. The District Office could be the principal for some of the work process and agent for the some of the work process. The main activities of District Office is quality checking, district database updating, data transfer to the Central Office and preparation of cadastral certificate. The Local Authority could be

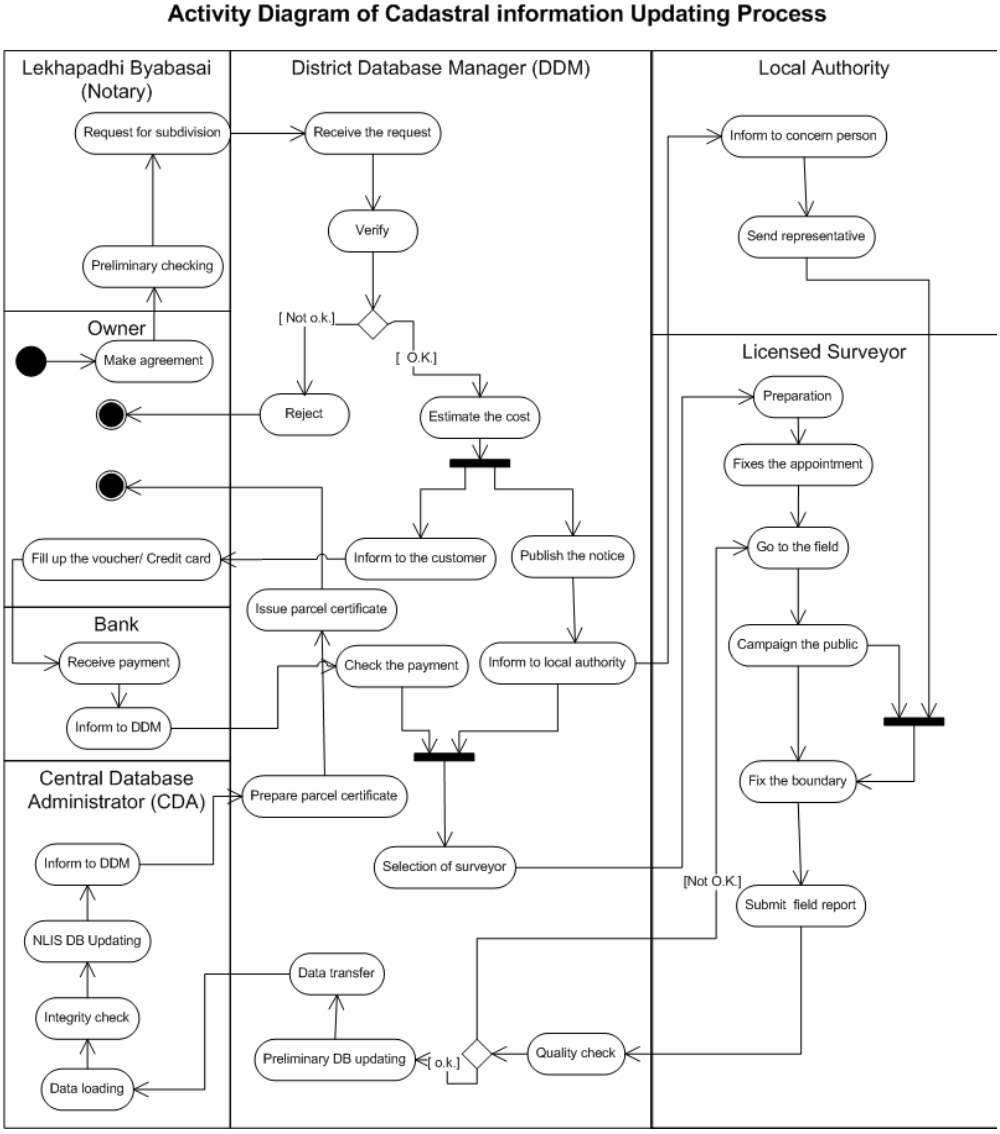

Fig 2: Activity diagram of Cadastral Information updating process

the agent for CI updating process. The main activities done by the Local Authority are witness for the boundary demarcation and to provide house/road information and tax payment information.

Modeling of Cadastral Information Updating Process

The CI updating process has been modeled taking Object – Oriented (OO) modeling approach. The worldwide accepted standard modeling language; i.e. the unified modeling language (UML) having Object -Oriented (OO) concepts has been used for modeling updating process. The Visio 2003 software has been used for modeling activities and The UML activity diagram is used to explore and describe the activities in CI updating processes.

There are seven main actors involved for the CI updating process. The Owner, Lekhapadhi Byabasai, District Database Manager (DDM), Bank, Licensed Surveyor, Local Authority and Central Database Administrator (CDA) are involved in the CI updating process. The activities for CI updating process involve the following 20 main steps displaying the following basic flow of events and alternatives with seven actors.

The Lekhapadhi Byabasai performs preliminary checking of the documents and sends the request for the subdivision of parcel. The District DB Manager (DDM) checks the application and verifies it. The DDM estimates the cost and informs the owner. The Bank receives the payment and informs to the DDM. The DDM assigns the field work to the licensed surveyor and publishes the notice.

The Licensed Surveyor retrieves the necessary data from database and makes the preparation for field work. He/She then fixes the appointment with owners and local representative and fixes the parcel boundary in the presence of local representative and owners. The licensed surveyor prepares the field report with field sketch and measurement and signed by local. The Licensed surveyor submits the field report to the District Database Manager (DDM). The DDM checks the quality of field work and updates the preliminary spatial database at District Office. The DDM transfers the updated information to the Central DB Administrator (CDA). The CDA loads the data and checks the integrity. The CDA updates the NLIS database and informs the DDM. The DDM prepares the parcel certificate and issues it. The new owner receives the parcel certificate or the Lekhapadhi Byabasai receives the parcel certificate on the behalf of new owner. One copy of parcel certificate will be sent to the Land Registry Office.

In the beginning; the District Database Manager transfers the updated CI to the Central Office. According to the P-A relationship both authority and activities for the updating of CI is at Central Level. When communication infrastructure will be developed and become affordable the NLIS database will be directly accessed and updated by DDM i.e. the activities will be transferred to the District office and authority will be at the Central Office.

Verification of the Model

There are two methods used for the verification of the 'Activity Model'. The first one is the model was conceptually verified by developing use cases with the help of activity diagram each of the use cases were realized developing sequence and class diagram in UML. The second one is the model was experimentally verified with the help of ArcCadastre software.

Verification 1

The UML use case diagram is used for the conceptually verification of the model. The purpose of use case diagram is to list the actors and use cases, and show which actors participate in which use case. There are six actors interacting with four use cases in a system whose boundary is defined by 'Cadastral Information Updating Process' is shown in the fig 5.2 The six actors are; Lekhapadhi Byabasai, Bank, Licensed Surveyor, Owners,

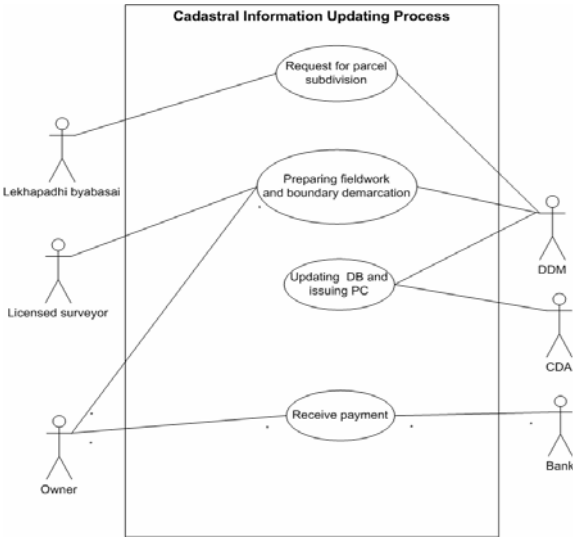

Fig 3: Use case diagram of Cadastral Information updating process

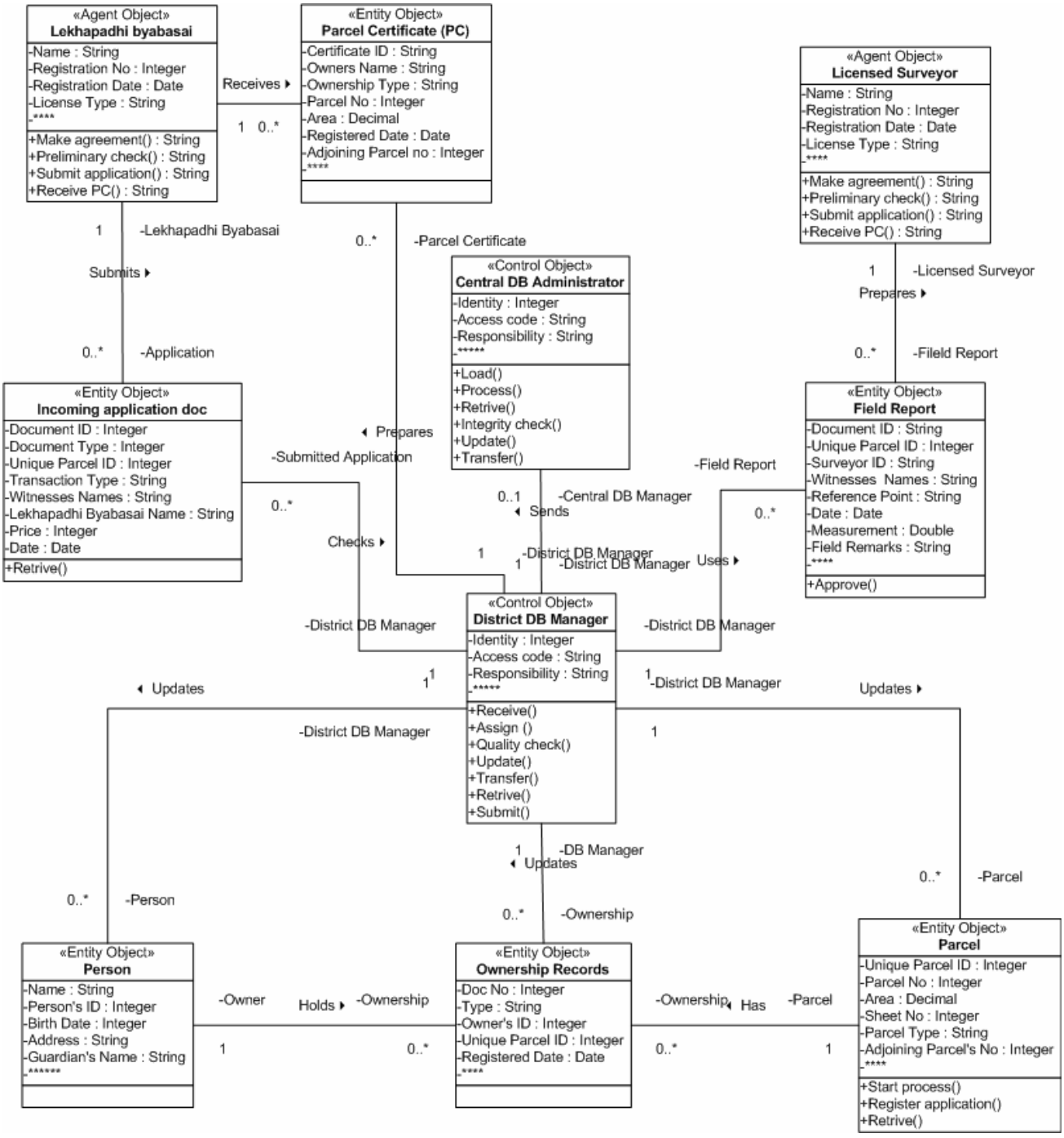

Fig. 4: Class diagram of Cadastral information updating process

District Database Manager (DDM) and Central Database Administrator (CDA). There are four use cases: Request parcel subdivision, Receive payment, Preparing field work and boundary demarcation, Updating database and issuing PC.

In the CI updating process, the use cases developed in Fig. 3 have realized modeling the actors and use cases into three stereotypes control object, entity object and agent object. According to the P-A relationship, the object having authority is modeled as control object and the object, which performs activities, is modeled as agent object. All the information necessary for the updating process is modeled as entity object. The Lekhapadhi Byabasai & licensed surveyor are the Agent Object; Central DB Administrator & District DB Manager are the Control Object and Incoming application documents, Field report, Person, Ownership records, parcel and parcel certificate (PC) are the entity objects. The class attributes and operations with various relationships among objects are shown in the Fig. 4

The four use cases developed in the Fig. 3 for CI updating process are also realized through four sequence diagrams.

Verification 2

Digital cadastral map derived from the cadastral map of 1: 500 scales and connected to the national geodetic reference system has been used for the experiment with ArcCadastre. First both spatial and non-spatial data were taken from DoLIA and linked using Arc GIS software. Those data were loaded in the ArcCadastre software. There are three preliminary works: creation of a new job template, creation of a job database from a template and creation of a new job from a job template to be done to organize the work processes in workflow editor in ArcCadastre software.

With the help of activity diagram described in Fig.1, the CI updating process is designed using ArcCadastre workflow editor. The workflow was saved as xml file format. The main workflow has been created for the CI updating process linking with four sub-processes as shown in Fig. 5. Workflow for each of the sub processes is also created and linked with the main workflow. The conditions are also created in the work flow.

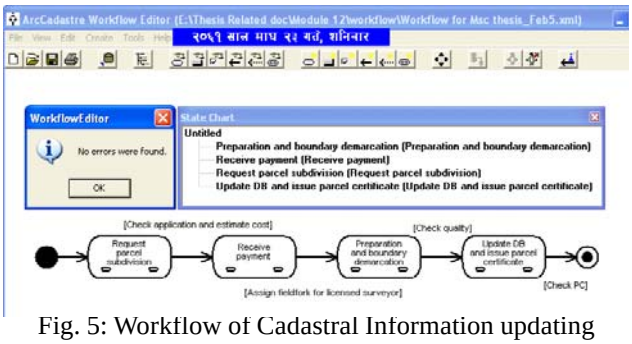

Fig. 5: Workflow of Cadastral Information updating process

Finally, a job template is created with the help of workflow described above. A new job is created with the help of job template and tested with the map document. The result is shown in the Fig. 6 below.

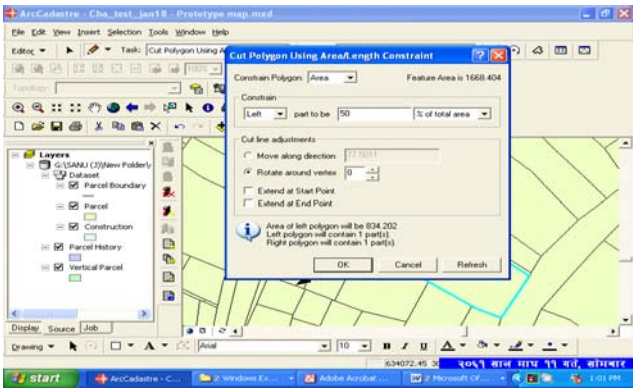

Fig. 6: Workflow tested with the cadastral map in ArcCadastre

Conclusions

This research first gives the introduction about the LIS development in Nepal and describes about the institutional and technical parameters to be considered for the determination of appropriate 'Activity Model' for cadastral information updating. The principal –Agent (P-A) theory approach is applied for the determination of 'Activity Model'. The 'Activity Model' was modeled using Object Oriented (O-O) modeling technique and verified conceptually with use case diagram realizing through class and sequence diagram and physically with ArcCadastre software with direct link to geo-database (cadastral map). This research concludes that the Centre Activity Centre Authority (CC) is optimal for Nepal for CI updating process incorporating P-A relationship approach.

References

Bogaerts, T., 1999. "Cadastres in the Phare Countries -Organisation Most Important Critical Success Factor." GIM International

Bogaerts, T., 1999. Cadastral systems: Critical success Factors; Information Technology in the services of local government planning and management, Urban Data Management Society (UDMS), Venice.
Brehm, J. and S. Gates, 1997. Working, Shirking, and Sabotage: Bureaucratic Response to a democratic public

de Vries, W. T., 2004. Purpose and forms of institutions and regulations, Lecture notes, GIM module 5, ITC, Enschede, the Netherlands

ECE, 1996. Land Administration Guidelines with Special Reference to Countries in Transition. U. N. Publication, S. N. E. II.E.7 and I. 92-1-116644-6. New York and Geneva, 1996: 111.

NPC, National Planning Commission, 2002. Tenth National Plan (2002-2006), Kathmandu

Radwan, M. and Y. Bishr, 1998. Technical Aspect of GII, Lecture notes, ITC, Enschede, the Netherlands

Steudler, D., 2004. A Framework for the Evaluation of Land Administration Systems, Department of Geomatics, the University of Melbourne, Melbourne

Tuladhar, A. M., 2004. Parcel Based Geo - Information System: Concepts and Guidelines. Delft, Technische Universiteit Delf: 270