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A Review of Case Study Research Strategy in Studies of Cadastral Systems

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ABSTRACT

The purpose of this article is to analyze the use of case study research strategy in the field of cadastral studies. The study reviews nineteen doctoral dissertations published in the cadastral research domain. The theoretical background of the case study research strategy is first explained. Major characteristics of the case study research strategy are then identified. Finally, guidelines are provided for the research approach, research design, data collection and data analysis focusing the cadastral case researches.

Characteristic of “contextual inclusiveness” of the cadastral system and “how” and “why” questions posed by the researchers on contemporary events have mainly guided researchers to select case study research strategy in cadastral studies. The research design depends largely on the research problem and can be categorized into two groups as; Top-down and Bottom-up design approaches. Theory building prior to data collection process acts as a good foundation for the case studies. High intensity usage of case study research strategy is evident among real world application related issues rather than design focused issues. Multiple-case design approach and multiple data collection methods are popular among the cadastral researchers.

1 Introduction

There has been a growing interest in the cadastral research methodologies among researchers. Several authors, for instance Silva and Stubkjær (2002), Çağdaş and Stubkjær (2009) and Çağdaş and Stubkjær (2011), showed strategic directions of methodologies to be used in this domain. The methodologies used here are mainly those of the social sciences (Silva and Stubkjær, 2002), and qualitative evaluation methods are more prominent (Çağdaş and Stubkjær, 2009). The case study research strategy is dominant in the empirical stage of these researches. Although many cadastral studies have used the case study research strategy, very few elaborated the theoretical concepts behind this. This paper reviews the use of the case study research strategy in studies of cadastral systems. The importance of the case study research strategy and their usage in the studies of cadastral systems are elaborately investigated and discussed in this paper.

Many researchers explored different aspects of the

cadastral systems. Scientific research in this domain has been increasing during the last three decades (Çağdaş and Stubkjær, 2009). Different international organizations, for instance: International Federation of Surveyors (FIG), United Nations (UN), World Bank, and European Union, academic research groups (for instance - research group of Geoinformation, <http://www.geoinfo.tuwien.ac.at/> in Vienna University of Technology, The Centre for Spatial Data Infrastructures and Land Administration, <http://www.csdila.unimelb.edu.au/> in The University of Melbourne, Land and Urban Systems in the Faculty of Geo-Information Science and Earth Observation (ITC) at University of Twente), and individual researchers have published their research findings in scientific journals, conferences, reports, books, and doctoral dissertations. Among them, the doctoral dissertations are rich in detailed and descriptive information about these studies. As this study is mainly based on the literature and focuses primarily on research methodology, it centers on the doctoral dissertations. This work selected publications available on the World Wide Web that puts more emphasis on the latest development in the field. Nineteen doctoral dissertations were selected and reviewed, and the selected dissertations can be grouped according to their prominent research focuses as follows.

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2 The Research Domain of the Reviewed Dissertations

Land administration framework and related issues have been the focus of the studies of Dalrymple (2005), Steudler (2004), Ting (2002) and Bennett (2007). Dalrymple (2005) investigated the land administration framework guiding the development of the rural poor to assess whether it meets sustainable development and poverty alleviation objectives set by current land policies. In her research, she conducted three case studies in rural Cambodian villages. Steudler (2004) took a more holistic approach of the land administration system. His study aimed to develop a methodology to measure and compare the performance of existing land administration systems and establish a framework based on indicators that will allow the evaluation and monitoring of land administration systems. He used four cases of land administration systems as, Switzerland, Sweden, Latvia and Lithuania in his study. Ting (2002) inquired on principles guiding the development of land administration infrastructures to address the evolving rights, restrictions, and responsibilities between government, private sector (corporate entities), community groups and individuals to support sustainable development objectives. She used three primary case studies as, New Zealand, New Brunswick and Canada, with some supportive materials from Victoria, Australia. The issue of management of land rights, restrictions and responsibilities was addressed by Bennett (2007). He aimed to develop a framework for understanding and organizing the management of property rights, restrictions and responsibilities in a way that enables the achievement of sustainable development objectives by citizens and government. He used the mixed methodological approach and both the top-down and bottom-up perspectives when answering the research questions. Each perspective was supported by three case studies.

Cadastral system reform, development and land boundary problems have been the research focus of the studies of Whittal (2008), Silva (2005) and Park (2003). Whittal (2008) attempted to develop a framework to guide the process of reform of a fiscal cadastral system while Silva (2005) inquired the mechanisms that cause the cadastral development. Whittal (2008) used the General Valuation Project 2000 of the city of Cape Town as a case study. Silva (2005) used Spanish cadastre, Portuguese Agricultural Parcel Identification System and Portuguese cadastre as case studies. The problem in land boundary variation was researched by Park (2003). He investigated potential solutions for those instances where a discrepancy is found to exist between the locations of the boundary as it was laid out and the actual occupational boundary currently in use. Park (2003) used few court cases involving boundary disputes in Australia, particularly the states of New South Wales and Victoria, and one court case from New Zealand as case studies.

Land tenure issues are prominent in the studies of Arko-Adjei (2011), Lengoiboni (2011), Nkwae (2006) and Rakai (2005). Arko-Adjei (2011) investigated on how land

administration systems in peri-urban areas can be adapted to the tenure forms and institutional frameworks of customary tenure systems. He used three customary tenure groups in Ghana as case studies. Lengoiboni (2011) researched on how pastoralists' seasonal land rights could be accommodated within the legal framework for real property rights and land administration. She conducted her case study in Northern Kenya. Development of a conceptual framework for evaluating land tenure and land administration options that can evolve with the changing social and economic needs of peri-urban areas, was the specific objective of the study of Nkwae (2006), and was based on the case study of South Africa. Alleviating inequitable Eurocentric bias by developing an ethnocentrically equitable or neutral analytical framework for analysing and designing proposed reforms of Aboriginal land tenure and land administration systems was the aim of the research conducted by Rakai (2005). His study was based on the aboriginal communities in Canada. He used the "Mi'kmaw" land tenure systems in Nova Scotia as a primary case study and, "Nisga'a" and "Lheidli T'enneh" land tenure systems in British Colombia as supportive case studies.

Land registration exercise was highlighted in the studies of Zevenbergen (2002) and Griffith-Charles (2004). Zevenbergen (2002) inquired how the technical, legal, and organizational aspects, and their interrelations, affect the way a system of land registration is able to provide adequate legal security to owners and purchasers of real property within a given jurisdiction. He used four case studies of land registrations of Indonesia, Austria, Ghana and The Netherlands. Griffith-Charles (2004) investigated the sustainability issue of the land registration information systems established by land titling projects. Her study questioned whether land titling projects lead to the establishment or the invigoration of the formal land market in the medium term (10 – 20 years). She used land registration system of St. Lucia as a case study in her research.

Aspects of information sciences were based on the studies of Paixão (2010), Effenberg (2001), Tuladhar (2004), Bittner (2001), Kalantari (2008) and Stoter (2004). Paixão (2010) targeted to design a conceptual multipurpose land information management model for the rural cadastral systems in Brazil based on the user requirements, system methodologies development and project management. Effenberg (2001) aimed to bring a formal information systems approach to the system that manages the spatial cadastral information that is the basis of digital cadastral maps. He used the spatial cadastral system of Victoria, Australia, as the major case study and New South Wales, Australia, as a supportive case. The objective of the study of Tuladhar (2004) was to provide modeling concepts and guidelines for developing or reengineering a parcel-based geo-information system (PBGIS) that provides efficient and effective delivery of parcel-based geo-information products and services. He used Nepal and Bhutan cadastral and land registration systems as case studies. Bittner (2001) connected works from different fields as, the legal domain, Philosophy, Artificial Intelligence, Social Science and

Computer Science. He investigated the institutional structure of social reality. The study focused on the domain of land management in Austrian cadastre. He developed the agent-based model of reality in a cadastre and used two case studies (process of ownership transfer and conflict regarding land use) in the simulation stage. Requirements of the future land administration systems and the role of the Information Communication Technology (ICT) in the future land administration systems were investigated by Kalantari (2008). He developed a cadastral data model, which can incorporate both broader range of interests and new commodities in land information systems and facilitated interoperability within various organizations and end users. Kalantari (2008) used three primary case studies reviewing current developments and the utilization of ICT in Australian land administration systems, including Victoria (Vic), New South Wales (NSW) and Western Australia (WA). The issue of recording 3 dimensional (3D) situations in cadastral registration in order to improve insight into 3D states was the research focus of Stoter (2004). She focused on the technical aspects of cadastral registration and used six cases from the Netherland and another six international cases in support of the study.

These studies can broadly be classified in to two according to the classification suggested by Çağdaş and Stubkjær (2009) as follows;

1. Social and behavioural sciences aspects – Ting (2002), Zevenbergen (2002), Park (2003), Griffith-Charles (2004), Steudler (2004), Dalrymple (2005), Rakai (2005), Silva (2005), Nkwae (2006), Arko-Adjei (2011), Lengoiboni (2011) and Bennett (2007).
2. Information sciences aspects – Bittner (2001), Effenberg (2001), Stoter (2004), Tuladhar (2004), Paixão (2010), Kalantari (2008) and Whittal (2008).

3 What is Case Study Research?

From the above description, it is evident that the case study research strategy is common in the cadastral research domain. Here, we do not see the case study as either a data collection tactic or merely a design feature alone but as a comprehensive research strategy (Stoecker, 1991; Yin, 1994). Different authors used different terminology for the term “research strategy”, for instance “strategies of inquiry” by Denzin and Lincoln (2011) and Creswell (2003), “varieties” by Tesch (1990), “traditions” by Creswell (1998), “methodologies” by Merten (1998), “models” by Moustakas (1994) and “theoretical traditions and orientations” by Patton (1990). Case study research strategy holds a long history among different research domains, for instance; psychology, anthropology, sociology, history, political science, education, economics, management, biology and medical sciences (Flyvbjerg, 2011; Gerring, 2007). Traditionally, the case research strategy has been associated with qualitative studies. Yet, at present, it has been well established within both the qualitative and quantitative evaluation paradigms. Many authors defined the term “case study” in many ways (David, 2006; Flyvbjerg, 2011; Gerring, 2004; Gerring, 2007). More specifically, some see the case study strategy purely in a

qualitative way, for instance Stake (1995) and Creswell (1998). While others, for example Yin (2003) and Gerring (2007), streamline their arguments between both the qualitative and quantitative paradigms.

Variations among case studies are highlighted by many researchers. For example, Ragin and Becker (1992) highlight the fact that the researchers answer the question “What is a case?” in remarkably different ways and this affects the whole research strategy. He suggests two dichotomies to categorize the answers for the above question. The first is that the understanding of cases as empirical units or as theoretical constructs. The second is between the specific and general case conceptions. Yin (1993) elaborates another significant variation of the case studies by considering their purposes as: exploratory, descriptive and explanatory. Gerring (2007) discusses another categorization by considering the case study format as: (a) number of cases encompassed (one, several or many), (b) the kind of X/Y variation exploited (spatial or temporal), and (c) the location of that variation (cross-case or within-case). As suggested by Gerring (2004) and Flyvbjerg (2011), despite all these variations, the holistic approach of defining the term case study research strategy will result in a definitional morass. “In many respects “What is a case?” is a conversation that for us has no real beginning or end” (Ragin and Becker, 1992). Thus, this study attempts to neither define the term nor to extend the discussion with the loose terminology. Instead, it summarizes the scope and major characteristics of the case study research strategy by positioning this study on the middle path, by considering the case study as a research strategy that can be accommodated by both the qualitative and quantitative evaluation methods. This approach is more agreeable with the reviewed dissertations in this study.

Scope

- The case study focuses to provide an in-depth study on a single phenomenon within its real-life context (Gerring, 2004; Yin, 1994).

Characteristics

- The research strategy especially copes with situations where the boundaries between phenomenon and context are unclear
- It relies on multiple sources of evidence
- The evidence may be either qualitative or quantitative
- The investigator may not control the environment but the results derived depend heavily on the investigative power of the investigator
- Benefits from prior development of theoretical propositions to guide data collection and analysis
- The focus is on a contemporary event

(Benbasat et al., 1987; Gerring, 2004; Yin, 2003)

4 Why Case Study Strategy for Cadastral Research?

Humankind and land relationship being a major component of the cadastral system, it has an inseparable relationship with its host society. It is generally accepted that two identical cadastral systems do not exist. However, without its host society, the cadastral system is likely a dead fish. This detachable quality of cadastral system and its host society makes cadastral researcher to study the phenomenon within its real-life context. Different research strategies suit for different research focuses. Yin (2003) suggests three components as vital to consider when selecting a research strategy for a research study. Table 1 shows these three conditions and their relationship with the five major research strategies (major for the cadastral research domain).

Table 1: Relevant situations for different research strategies (from Yin, 2003, p.5).

Research Strategy \ Condition	Form of Research Question	Requires Control of Behavioural Events?	Focuses on Contemporary Events?
Experiment	How, why?	Yes	Yes
Survey	Who, what, where, how many, how much?	No	Yes
Archival analysis	Who, what, where, how many, how much?	No	Yes / No
History	How, why?	No	No
Case study	How, why?	No	Yes

The first condition is to form the research question post in terms of “who”, “what”, “where”, “how” and “why”. This provides an important clue regarding the most relevant research strategy to be used. The “Experiment”, “History” and “Case Study” research strategies are most likely to be appropriate for “how” and “why” questions. An experiment research strategy can be employed for studies which require the deliberate detachment of the phenomenon from its context, or requires control of behavioral events due to the reason that a few variables need special attention. Comparatively, surveys can be used to study the phenomenon that does not require control of behavioral events within its real-life context, but their ability to investigate the context is very limited. On the other hand, history can be used to study a phenomenon within its real-life context, but usually with non-contemporary events. Archival analysis can be used to study the phenomenon within its real-life context for both contemporary and non-contemporary events, but its investigative power is limited and based on the available archival information. Finally, the

case study method can be used to study the phenomenon comprehensively within its real life context for contemporary events. This research strategy is a distinctive form of an empirical inquiry (Yin, 1994). Thus the case study research strategy is popular among cadastral researchers.

All of the above mentioned researchers used case study research strategy for their studies, especially in the field inquiry stages. Although there are some situations which require a specific research strategy, there is no hard and fast rule as one research strategy for a particular study. For example, some of the above mentioned researchers used multiple research strategies in their studies, and yet, case study strategy took a prominent place within their studies. For instance, Ting (2002) used historical exploration of the relationship of people to land as a useful background for the case studies carried out in the latter part of her study. She used surveys within the case studies to collect data. Thus the case study research strategy took prominent place in her research.

There are other types of research strategies, which are elaborately discussed by different authors, putting more emphasis on the qualitative inquiries, for example, biography, phenomenology, grounded theory and ethnography. A biography is a detailed and descriptive exploration of someone’s life history. Denzin (1989) defined the term biography as a “written account or history of the life of an individual. The art of written such account”. Phenomenology is the study of the structures of consciousness in human experiences. “Phenomenologists are interested in showing how complex meanings are built out of simple units of direct experience” (Merriam, 2002). The grounded theory research strategy was developed by Glaser and Strauss in the early 1960s (Glaser and Strauss, 1967). Theory generation is the principle aim of the researchers when using the grounded research strategy. The research strategy helps for the development of theory, without any particular commitment to specific kinds of data, lines of research, or theoretical interests (Strauss, 1987). Comparatively among these different types of research strategies, ethnography research strategy can be identified as a similar approach to the case study. In this end, both the strategies operate within the natural setting of the study objects, and both rely on multiple data sources, such as interviews, observations, and documents. From the opposite end, ethnography and case study strategies are poles apart due to three major reasons. Firstly, ethnography focuses to study a cultural and social group, but the case study focuses on an in-depth analysis of a single case or multiple cases not necessarily from the cultural and social group. Secondly, data collection on ethnography depends primarily through participant observation, but it is not mandatory for case studies. Finally, ethnography researchers spend extended periods in the field data collection, for instance 6 months to a year, but relatively shorter periods are taken by case study researchers for the field data collection (Creswell, 1998; Hammersley and Atkinson, 2007).

Another major decisive factor to choose case study research strategy is the research questions posed by the

study. If a “how” or “why” question is posed on a contemporary set of events, which researcher has little or no control, the case research strategy is the more promising solution to adopt (Yin, 1994). Among the selected research studies, Zevenberge (2002), Arko-Adjei (2011), Bennett (2007) and Lengoiboni (2011) pose the “how” question as their major research question, while a majority of the other researchers initially developed a theoretical framework or conceptual model and inquired its applicability for a specific case or cases by answering the question “how does this specific theoretical framework or conceptual model fit in to this case?”. Thus, different researchers use this case study research strategy in varying intensities for their studies. This fact is elaborately discussed in the next section of this article.

5 How is the Case Study Research Strategy Used in the Cadastral Research Domain?

5.1 Bottom-up vs. Top-down Case Approach

As elaborately discussed above, the characteristic such as “contextual inclusiveness” makes the case unique. Among the considered research studies, some researchers specifically inquire the context bounded problems. For an example, Griffith-Charles’s (2004) study is specifically focused on the land title registration project of St. Lucia Island in the Caribbean. Paixão’s (2010) is based on the rural cadastre in Brazil. Nkwae (2006) studied the customary peri-urban land problems in Botswana, Malawi and South Africa. Lengoiboni (2011), Arko-Adje (2011) and Rakai (2005) studied the land tenure issues in Northern Kenya, Ghana and Maritime Provinces of Canada, respectively. Silva (2005) specifically investigated the causes of cadastral development in Portugal and Spain. Whittal (2008) studied the General Valuation Project 2000 in the city of Cape Town. Park (2003) investigated the legal issues of land boundary variations by focusing on the Australian jurisdiction.

Others took holistic problems in the cadastral research domain as their major research problems and performed empirical investigations within the context bounded systems. They developed the frameworks, criteria, methods, models, and so on, and attempted to evaluate and generalise their findings by applying them to different context bounded systems.

All the researchers attempted the theory building prior to the data collection process. This approach helped them to make links between the case study findings and other theoretical frameworks and researches (Yin, 2003). Specifically, these theoretical directions helped them to guide their case studies and act as a good foundation for the case studies. Fig. 1 summarizes the two research designs, bottom- up vs. top-down approach. Fig. 1 summarizes the two research designs, bottom- up vs. top-down approach.

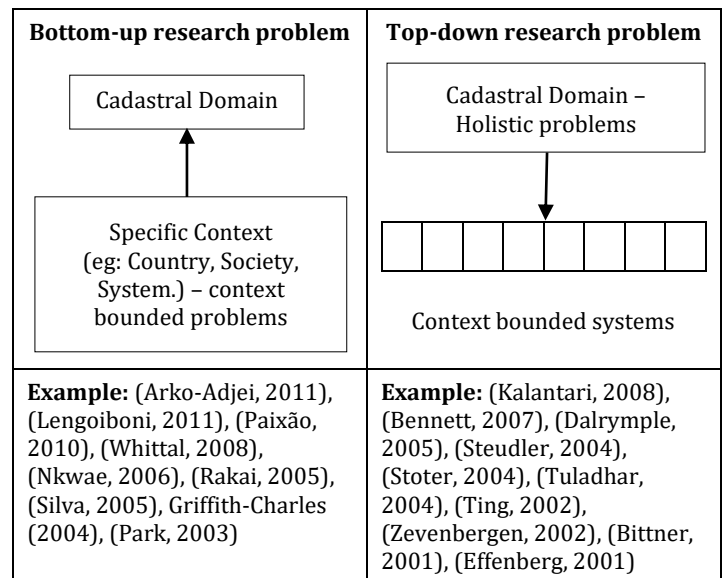


Fig. 1: Research design (bottom- up vs. top-down approach).

5.2 Intensity of Using the Case Research Strategy

This study considered the following factors when comparing the intensity of using case research strategy in the considered research studies.

1. Case research approach is used as the major research strategy in the study
2. Description given about the specific case or cases
3. Description given about the case research strategy

If the study fulfilled all the above three requirements, it was considered as having high intensity of usage of the case research strategy, if the study fulfilled only the first two, it was considered as having medium intensity usage of the case research strategy, and if its fulfilled only the second one, it was considered as having low intensity of usage (see [Appendix 1](#)). It is evident from the considered research studies that the intensity of the case study approach is mainly dependent on the level of empirical inquiry by the researchers. Researchers researching on the issues of information systems and technologies give more weight to the design and development issues rather than to the empirical issues. For example, Brittner (2001) focuses on the agent base modeling of reality in a cadastre. He uses two processes of the Austrian cadastral system for the simulation of the developed model. Kalantari (2008) focused mainly on developing the new cadastral data model as a tool for e-land administration. He used case studies to inquire the current ICT enablement of land administration systems in three Australian states. Stoter (2004) inquired the recording of 3D situations in cadastre and she focused more on to the 3D representation issues. The cores of these studies are design related issues rather than the real world application related issues. Thus, the case study approach is not much used within these studies and did not stand as a comprehensive research strategy.

5.3 Single-Case vs. Multiple-Case Design

The decision about to include a single case or multiple cases is central for any case research design. Most of the selected case studies have used multiple case research designs, while a few used single cases. Yin (2003) has elaborately discussed the variations of these two design approaches and suggests single case studies are suitable if;

1. it represents the critical case in testing a well-formulated theory
2. it represents an extreme or unique case
3. a case is representative or a typical case (representative among number of cases in the same type)
4. it is a revelatory case (situation where the case is previously inaccessible to scientific investigation)
5. it is a longitudinal case (studying the same case at two or more different time)

Gerring (2007, p.89), to give a more homogeneity to case categorization, introduced nine techniques for the case selection, named as; (1) typical, (2) diverse, (3) extreme, (4) deviant, (5) influential, (6) crucial, (7) pathway, (8) most-similar, and (9) most- different. Swanborn (2010) suggested selecting all available cases in to five instances, while Yin (2003) suggested to use the single case design approach. He further suggested using random selection and pragmatic grounds (distance, time, money, accessibility) as an additional criterion for the case selection, and introduced substantive criteria for the case selection.

The single case study can further be subdivided as holistic and embedded case studies by considering the number of units of analysis accommodating for the study. In holistic case studies, the case study accommodates only a single unit of analysis. While in the embedded case studies, more than one unit of analysis are involved (Yin, 2003). However, a clear definition including what comprises a unit of analysis remains vague in literature (Lee et al., 2009). Up to which extent that unit can breakdown is also problematic. To prevent confusion between the data collection unit and the unit of analysis, scholars used different terminology, such as “case versus case-within-the-case” (Gerring, 2007; Stake, 1995), “case versus subunit” (Bergen and While, 2000), or “holistic versus embedded” case (Yin, 2003). For example, Steudler (2004) developed a framework and methodology to evaluate and compare the land administration systems. His major data collection unit was land administration system and this was further subdivided as institutional framework, cadastral system and cadastral mapping. He used land administration system as his major unit of analysis. This unit can be further subdivided into five as (1) policy level aspects, (2) management level aspects, (3) operational level aspects, (4) external factors aspects, and (5) review process aspects. Only few researchers specifically mentioned their “unit of analysis” among our considered set of research studies, such as; Zevenberge (2002), Arko-Adjei (2011) and Lengoiboni (2011). Due to having an uncertainty about the definition of the “unit of analysis”, this study only

attempted to categorize the selected dissertations based on their major units of analysis (see [Appendix 1](#)).

Four studies used the single case design among our selected set of research studies (see [Appendix 1](#)). Whittal (2008) uses the GV 2000 project (General Valuation project 2000 in the city of Cape Town) as a case study. The case is unique because the project used Computer Assisted Mass Appraisal (CAMA) techniques for the first time in South Africa to appraise more than 540,000 residential properties within a short period of time. The case is revelatory as well, because there were no studies carried out on this project previously and the researcher had fair background to investigate the project. The case was longitudinal (studying the same case in different occasions), because data was collected from 1999 to 2007. Griffith-Charles (2004) used the land-title registration project of St. Lucia as a case study. Her case study was more characteristic of a representative or a typical case, because similar type of land titling projects supported by different donor organizations are available throughout the world. In general, her investigation supplied the answer to whether the investments in the improvements of land administration systems were socially and economically viable. Paixão (2010) designed a multipurpose land information management conceptual model for rural cadastral system in Brazil based on the user requirements, system methodologies development and project management. He used the national cadastral system of rural properties in Brazil as a case study. The case was unique because the user requirements were unique for the rural Brazilian context. Lengoiboni (2011) used the case study of Samburu-Laikipia-Isiolo-Meru landscape in Kenya with six embedded units of analysis consisting of six categories of land use actors (pastoralists, farmers, private ranchers, urban residents, wildlife park wardens and forest officers). This case study can be characterized as a unique case, because the selected area represented all seven agro-ecological zone types found in Kenya, and the pastoral seasonal land use is characterized by the seasonal movements across the area. Further, the selected area is rich in diversity of land uses, land use actors and land tenures. Thus, this environment provided an ideal context to achieve the research objectives.

In multiple-case design, the study may contain more than a single case. This can also be subdivided as a holistic (single unit of analysis) or embedded (multiple unit of analysis) case designs. The multiple-case study follows the replication logic, which is not to be confused with the sampling logic where the selection is made out of a population. Each case serves a specific objective within the whole research design and each single case can be considered as a single experiment (Yin, 2003). He further explains the replication logic behind this multiple-case study design by categorizing the multiple-case study design in to two as (1) cases designed to predict similar results (a literal replication) and (2) cases designed to predict contrasting results but for predictable reasons (a theoretical replication). Gerring (2007, p.89) suggested the diverse, most-similar and most-different case selection methods as highly appropriate for multiple case designs.

The majority of our selected research studies use this multiple-case design strategy (see [Appendix 1](#)). Interestingly, according to Yin's (2003) classification, all these cases followed the literal replication approach.

5.4 Data Collection Methods

Multiple data collection methods are typically employed in the case research studies. This will help to improve the construct validity and secure the reliability of research findings. Yin (2003, p.83) identified several sources of evidence that are highly appropriate for the case research as;

1. Documentation – written materials such as; letters, memoranda, reports, administrative documents, newspaper articles.
2. Archival records – computer files and records, service records, maps and charts, personal records, survey data.
3. Interviews – open-ended, focused interviews and interviews entailing more structured questions.
4. Direct observations – passive observations done in the field
5. Participant-observations – actually participate in the events being studied and doing the observations.
6. Physical artifacts – devices, outputs and tools.

Specific data collection methods to be used will depend heavily on the research objectives. However, no single method has a complete advantage over all the others. Thus, a good case study research may use as many sources as possible. The majority of our selected research studies used documentation, interview, direct observation, and participatory observations as data collection methods (see [Appendix 1](#)), while Park (2003) and Bittner (2001) used only literature sources (documentation and archival records) as their data collection method in case studies. Interestingly, Dalrymple (2005), Bennett (2007), Arko-Adjei (2011), Zevenberge (2002), Stoter (2004) and Lengoiboni (2011) used field photographs as a source of data, which added extra value to their data collection. However, it is noticeable that the majority of researchers were not well aware of documenting their data collection methods and procedures.

6 Conclusion

Case study research strategy is highly popular among cadastral researchers. This study provided guidelines for research approach, research design, data collection and data analysis, focusing on the cadastral case researches. Characteristic of “contextual inclusiveness” of the cadastral system and “how” and “why” questions posed by the researchers on contemporary events, are the main guides to select the case study research strategy for cadastral researches. The case study research strategy is specifically adopted in the empirical stages of these researches.

In the research design stage, some cadastral researchers focused on context-bounded problems and conducted their empirical investigations targeting to answer a holistic problem in the cadastral domain. Others took holistic problems in cadastral domain and performed their empirical investigations within context-bounded systems. Theory building was conducted prior to the data collection process by both the bottom-up and top-down research approaches. This helped them to guide their case studies and act as a good foundation for the case studies.

The intensity of the case study approach depends mainly on the level of empirical inquiry used by the researchers. High intensity of usage of case study research strategy is evident among real world application related issues, rather than among design focused cadastral studies. The decision to include single or multiple cases is central for any case research design and depends on the requirements of the study. Majority of the selected studies adopted multiple-case design approach and multiple data collection methods.

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Author Contributions

Conceptualization, methodology, analysis, writing - original draft preparation, H.D., and writing - review and editing, C.T. All authors have read and agreed to the published version of the manuscript.

Conflict of Interest

The authors declare no conflict of interest.

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Appendix 1

Author / Year / Title	Quantitative vs. Qualitative Approach	Case thrust	Brief description about the cases used	Level of intensity of the case research strategy	Major Methods of data collection	Unit/ Units of analysis
Ting, L.A. / 2002 Principles for an integrated land administration system to support sustainable development	Qualitative	How the legal and institutional infrastructures for land administration could be re-engineered to better support sustainable development objectives	Two primary cases as; 1. New Zealand 2. New Brunswick, Canada And one supportive case from Victoria, Australia	High 1,2&3	Interview, Questionnaire Survey, Different literature sources	Three embedded units of analysis for each case study (1) land administration system (2) changes in rights and responsibilities over land and its use (3) the way these changes are addressed from legal, institutional and technology perspectives
Steudler, D. / 2004 A framework for the evaluation of land administration systems	Qualitative	How does the developed evaluation framework fit in to the land administration systems in different countries?	The developed evaluation framework was tested by evaluating Land administration systems in 1. Switzerland 2. Sweden 3. Latvia 4. Lithuania	High 1,2&3	Interview, Non-participant observation, Different literature sources	Land Administration System
Dalrymple, K. / 2005 Expanding rural land tenures to alleviate poverty	More qualitative than quantitative	Why and how questions on the informal rural land tenure	Rural Cambodian villages 1. Chi Meakh 2. Srae Srama 3. Ou Ta Prok	High 1,2&3	Participant observation, Interview, Different literature sources	Three embedded unit of analysis with each case study (1) land policy for sustainable development, (2) land administration projects for sustainable development (3) land tenure
Bennett, R. / 2007 Property rights, restrictions and responsibilities: their nature, design and management	Quantitative and Qualitative (Mixed method approach)	How should we organize the management of property rights, restrictions and responsibilities in a way that enables the achievement of sustainable development objectives by citizens and government?	Top-Down Approach – 3 cases 1. Federal Government Australia 2. The State Government of Victoria 3. Moreland city council Bottom- Up Approach – 4 cases 1. Three cases from Victoria, Australia 2. One case from New South Wales, Australia	High 1,2&3	Interview, Non-participant observation, Survey, Different literature sources, Participant observations	land interest (property rights, restrictions and responsibilities)

1 – Case study research approach is selected as a major research approach 2 – Describing the specific case 3 – Describing the case study theory
 (1&2&3) – High intensity of the case research approach (1&2) – Medium intensity of the case research approach 2 only – Low intensity of the case research approach

Author / Year / Title	Quantitative vs. Qualitative Approach	Case thrust	Brief description about the case/cases used	Level of intensity of the case research strategy	Major Methods of data collection	Unit of analysis
Silva M.A. / 2005 Modelling causes of cadastral development - Cases in Portugal and Spain during the last two decades	Qualitative	How did this initially develop "Profit + resources" model based framework to fit in to the specific case?	Developed model was applied for three cases 1. Spanish Cadastre 2. Portuguese Agricultural Parcel Identification System 3. Portuguese Cadastre	High 1,2&3	Interview, Different literature sources	Cadastral System
Whittal, J. / 2008 Fiscal cadastral systems reform- a case study of the general valuation project 2000 in the city of Cape Town	Qualitative	How this developed theoretical and methodological framework for – does fiscal cadastral system reform- fit in to this case?	Single case study of the general valuation project 2000 in the city of Cape Town – based on longitudinal data collected from 1999 up to 2007 (most of the data were collected between 2001 to 2002)	High 1,2&3	Non-participant observation, Interviews, Different literature sources	Fiscal Cadastral System
Park, M.M. / 2003 The effect of adverse possession on part of a registered title land parcel	Qualitative	Investigation of how boundary variation or adjustments or both are permitted within the Australian jurisdiction	Three court cases involving boundary location of registered title land parcels 1. Malter v Procopets (Victoria) 2. Woodward v Wesley Hazell (Tasmania) 3. Cotton v Keogh (New Zealand) Apply various schemes for each case study as;- New South Wales, Queensland, Victoria, Tasmania, South Australia, Western Australia, New Zealand	Medium 1&2	Different literature sources	Seven embedded units of analysis with each case study Seven jurisdictions (New South Wales, Queensland, Victoria, Tasmania, South Australia, Western Australia, New Zealand)
Arko-Adjei, A. / 2011 Adapting land administration to the institutional framework of customary tenure – the case of peri-urban Ghana	Qualitative and Quantitative	How does this defined land administration framework fit in to the specific case?	Multiple cases of land tenure and tenure institutions (peri-urban areas) in Ghana (three cases to cover the three main land tenure groups in Ghana) 1. Tamale Skin Land 2. Japekrom Stool Land 3. Gbawe- Kwatei Family Land	High 1,2&3	Interview, Different literature sources, Participatory observations, direct observation	Three embedded units of analysis with each case study (1) Dynamics of land tenure, (2) Good land governance (3) Indigenous knowledge and local capacity
Lengoiboni, M. / 2011 Pastoralists seasonal land rights in land administration : a study of Northern Kenya	Quantitative than qualitative	How could pastoralists seasonal land rights be accommodated within the legal framework for real property rights and land administration?	Case study was based on the Samburu, Laikipia, Isiolo, Meru Landscape in Kenya Six unit of analysis (different land use actors) 1. Pastoralists 2. Farmers 3. Private Ranchers 4. Urban Residents 5. Wild Life and Forest Officers 6. Park Wardens	Medium 1&2	Semi-structured questionnaires, Interviews, emails	Six embedded units of analysis with each case study (Six different land use actors)

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Author / Year / Title	Quantitative vs. Qualitative Approach	Case thrust	Brief description about the case / cases used	Level of intensity of the case research strategy	Major Methods of data collection	Unit of analysis
Nkwae, B. / 2006 Conceptual framework for modelling and analysing peri-urban land problem in Southern Africa	Qualitative	How does this soft system methodology based conceptual framework fit in to the specific case?	Three major case studies based on land tenure and land administration requirements of periurban areas in 1. Botswana 2. Malawi 3. South Africa	Medium 1&2	Questionnaire, Interview, direct observation, Different literature sources	Two embedded units of analysis with each case study Land tenure Land administration
Rakai, M.E.T. / 2005 A neutral framework for modelling and analysing aboriginal land tenure systems	Qualitative	How does this developed conceptual analytical framework fit in to the specific case?	Aboriginal land tenure systems in Canada's maritime provinces 1. Mi'Kmaq land tenure system in Nova Scotia on the east coast as the main case study 2. Nisga'a and the Lheidli T'enneh nations in British Columbia on the west coast as a supportive case study	Medium 1&2	Meetings, unstructured interviews, Different literature sources	Two embedded units of analysis with each case study (1) Land tenure (2) land administration
Zevenberge, J. / 2002 Systems of Land Registration- Aspects and Effects	Qualitative	How do the technical, legal, and organizational aspects and their interrelations affect the way a system of land registration is able to provide adequate legal security to owners and purchasers of real property within a given jurisdiction?	Four cases of land registration systems are used 1. The Netherlands 2. Indonesia 3. Austria 4. Ghana	High 1,2&3	Interviews, different literature sources, direct observations	Land registration system
Charisse-Griffith C. / 2004 The impact of land titling on land transaction activity and registration system sustainability: a case study of St. Lucia	Quantitative than Qualitative	How does this developed methodology for testing for medium term impact after systematic land titling fit in to the case of St. Lucia?	Single case study of the land-title registration project of St. Lucia	Medium 1&2	Questionnaire survey, Interview, different literature sources	Land registration system
Paixao, S.K.S. / 2010 Design of a conceptual land information management model for the rural cadastre in Brazil	Qualitative	Purpose of the case study was to identify user requirements for national cadastral system for rural properties (CNIR)	Single case study of the national cadastral system of rural properties in Brazil	Medium 1&2	Interview, Questionnaires, different literature sources, group meetings, emails, direct observations	Cadastral system

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Author / Year / Title	Quantitative vs. Qualitative Approach	Case thrust	Brief description about the cases used	Level of intensity of the case research strategy	Major Methods of data collection	Unit of analysis
Effenberg, W. / 2001 Spatial cadastral information systems – the maintenance of digital cadastral maps	Qualitative	How does this Zachman Framework fit in to the spatial cadastral system of Victoria, Australia?	One major case of digital spatial cadastral system of Victoria, Australia and one supportive case of digital spatial cadastral system of New South Wales, Australia	Medium 1&2	Direct observations, interview, different literature resources	Digital spatial cadastral system
Tuladhar, A.M. / 2004 Parcel-based geo-information system: concepts and guidelines	Qualitative than Quantitative	How does this developed conceptual framework for developing and implementing a Parcel based geo-information system (PBGIS) fit in to the specific case?	Systems of cadastral and land registration in Nepal and Bhutan	Medium 1&2	Interview, workshop, meeting, different literature sources	Cadastral information system
Bittner, S. / 2001 An agent-based model of reality in a cadastre	Qualitative and Quantitative	How does this developed agent-based model of reality in a cadastre fit in to a specific case?	Two processes of the Austrian cadastral system The transfer of ownership of a parcel between two persons The conflict between two persons regarding the use of a piece of land	Low 2	Different literature resources	Cadastral system
Kalantari, S.M.S. / 2008 Cadastral data modelling – a tool for e-land administration	Qualitative	How Information Communication Technology (ICT) is used in land administration systems	Current development and use of ICT in land administration systems in Australia New South Wales Victoria Western Australia	Low 2	Direct observations, interview, different literature resources	Land administration system
Stoter, J.E. / 2004 3D Cadastre	Qualitative	How to record 3D situations in cadastral registration in order to improve insight into 3D situations	Six case studies of present situation of 3D cadastral registration in The Netherlands (three cases on multilevel building complexes in urban areas that interact with other land use and other three based on subsurface infrastructure objects) Present situation of 3D cadastral registration on; Denmark, Norway, Sweden, Israel, British Colombia(Canada) and Queensland (Australia)	Low 2	Direct observations, Cadastral registration data, workshops, different literature resources	Cadastral system (3D recording of cadastral data)

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