

# ASSESSING CADASTRE 2034 TO DEVELOP A FEDERATED CADASTRAL SYSTEM IN NEW SOUTH WALES AUSTRALIA: MIXED METHODS RESEARCH APPROACH

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### ABSTRACT:

Cadastre 2034 is a National Strategy developed by the Intergovernmental Committee on Surveying and Mapping (ICSM) for cadastral reform and innovation for Australia and one of the goals is to develop a federated cadastral system. It states to define governance and administration on a federal level by unifying the existing systems with uniform standards, policies, guidelines and legislation and to allow further work towards a global cadastre. The aim of this research paper is to explore the behaviours and attitudes of New South Wales (NSW) cadastre towards a federated cadastral system assessing the best practice of federated cadastre global cases that may be applied locally in Australia. Mixed Methods Research (MMR) methodology was used, involving both quantitative and qualitative research to understand, identify and frame the cadastral data to determine and analyse the key issues and factors in implementing a federated cadastral system in New South Wales (NSW). A literature review, a questionnaire survey and interviews were used to collect the quantitative and qualitative data. A sequential MMR design framework was used a questionnaire survey followed by interviews. The questionnaire was sent out to 215 industry and government participants and resulted 71 completed surveys. Semi-structured interviews were conducted with 9 participants. The linking of quantitative and qualitative data occurred at the design-level, where results from the first phase were used to build the second phase of research design.

It was explored that strong historical foundations, regressive reaction of governments and institutions, and a lack of understanding of the significance of cadastral reform were the key hindering factors to develop a federated cadastral system in NSW. The resulting analysis could be contributed to a better implementation of a federated cadastral system in NSW benefitting private, and public institutions.

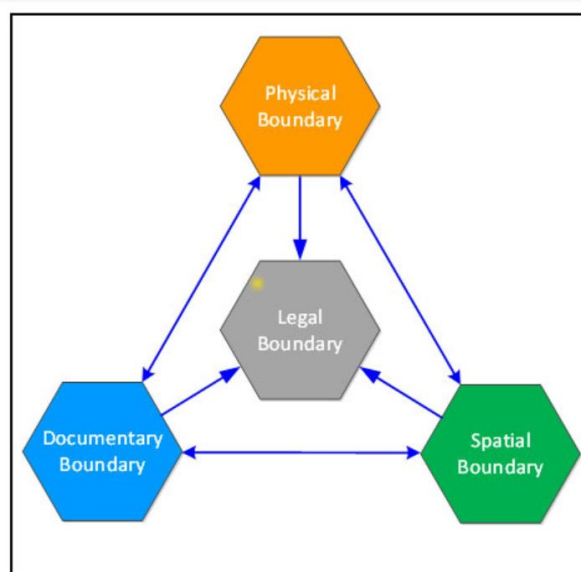
## 1. INTRODUCTION

### 1.1 Background

Over the last few decades there has been a trend to migrate from the manual cadastral systems to a new fully automated digital cadastral infrastructure. The Intergovernmental Committee on Surveying and Mapping (ICSM), national mapping agencies and state authorities have aimed to consolidate, simplify, and manage resources commonly held by the national and global populations. Australia has aimed to develop a federated cadastral system. The ICSM has been developing national strategy on national land and marine spatial infrastructure providing sustainable benefits, which would better enable users to ‘identify the location and extent of all rights, restrictions and responsibilities related to land and real property’ (ICSM 2017). The ICSM developed five goals to deliver the Cadastre 2034 strategy and Goal Five is to develop a federated cadastral system based on common standards (ICSM 2017).

In Australia, the current version of the cadastre exists in several forms with varying standards across multiple jurisdictions. Processes, policies, standards, guidelines, and legislation are not well defined. ‘A truly federated cadastre based on common standards’ (Hirst 2014) is achieved by implementing unify access to cadastres in multiple jurisdictions, to unify and simplify the policies, standards, guidelines and legislation. It is important to understand what a cadastral system is so that the

concept of a federated cadastral system may be fully appreciated.



**Figure 1.** Elements in a cadastral system (Source: Grant et al. 2018, p. 54)

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As illustrated in the Figure 1, the relationship within a cadastral system is best described and visualised by The Cadastral Triangular Model developed by Grant et al. (2018) incorporating the Legal Boundary, Physical Boundary, Documentary Boundary, and Spatial Boundary within the modern digital cadastral system. Presently each local government, state government and federal government have their own cadastral systems or databases. Development applications and land administration are impacted by hindered data flow which prolongs application time, processing time or even searching time, not to mention the cost to maintain duplicate systems. A single federated system aims to overcome these issues.

There are several jurisdictions in Australia in which the current cadastral system exists and in several forms. ICSM has developed a national strategy for cadastral reform and innovation for Australia, the aim of which is to create one single federated cadastral system integrating the state and territory systems, standards, legislation, policies, and governance (ICSM 2017).

In 1901 the Commonwealth of Australia was established however, each of the original jurisdictions maintained their own parliaments and courts. There are eight separate state and territory court branches, each with their own legislation and regulations. There is only one Federal Court branch, both State and Federal Courts are subject to the High Court. Matters are resolved within their own jurisdictions following the hierarchy with the High Court as the last point of call. In 1987 a cross-vesting scheme was formed to deal with multi-jurisdictional cases at a federal level (Oxford University 2013, p. 26). Likewise, the same may be said for parliament, if there is legislation enacted by parliament in one jurisdiction it is not reciprocated to another.

Each parliament in Australia enact legislation and regulations individually as is required for that particular jurisdiction (Oxford University 2013). Section 51 of the Australian Constitution does not support the creation of a Commonwealth Surveyors Act or even a Commonwealth Torrens Title Act, this is one of the legislative issues impeding a federal cadastral system. Providing a cross-jurisdictional and reciprocal of legislation and regulation might be the only avenue into a more harmonious order nationally. It would not be feasible to hold a referendum to amend The Constitution just to enact legislation already in existence at state/territory level.

Good cadastral reform by Cadastre 2034 will simplify and unify the cadastral systems (ICSM 2017). These systems cannot just be made obsolete and a new federated one created. The Constitution would have no power to enact it at a federal level. There are multiple cadastral systems in place which hold current cadastral data within every state and territory. The solution is rather to band together under the one banner. The Cadastre 2014 vision held early discussions of strategies, dating back to 1998, in attempting to achieve a federated cadastre (Kaufmann & Steudler 1998). Culminating in a three-decade long initiative, Cadastre 2034 continues where Cadastre 2014 left off. The ICSM considers Cadastre 2034 as a vital initiative for the future success and growth of Australia's economic, social, and environmental development (ICSM 2017). The overall strategy is to be in harmony globally, as set out by the United Nations Agenda 21, keeping in mind that, this research project focuses and limits its study area to NSW though strategies and common ground with other states and territories (Brackman 2020).

As the scope of research is quite narrow and no research projects have been carried out of this nature on any of the other states and territories, a comprehensive search of databases of journal articles, conference papers, research report and government documents have returned that a clear knowledge gap is evident in relation to the readiness of the implementation of a federated cadastre in NSW.

## 1.2 Knowledge Gap

Complexities involving multi-jurisdictional issues with current practices and legal barriers in Australian Cadastral Systems are affecting developments such as 3D & 4D cadastres (Ho et al. 2013). By potentially widening the gap in jurisdictional differences with respect to cadastral systems and how they are legislated, each jurisdiction would treat these complexities independently and differently. Steudler (2014) highlights that a regressive reaction to an implementation of cadastral reform is the 'stakeholders' fear of losing control of the data' in contrast to the principle of legal and institutional independence. Dalrymple et al. (2003) implies that the implementation of cadastral reform in Australia is impacted by 'strong historical foundations. A prevailing theme of a lack of understanding of the importance of cadastral reform being among a host of 'resistors to change', that Donnelly (2008) listed, was found at all levels of government and within the legal profession. Especially when considering boundary determination across multiple jurisdictions, Grant et al. (2018) found that the spatial boundary, the legal role, and best practice model warranted further investigation. Clearly distinguished benefits and the significance of cadastral reform in Australia, provides vision, sets out strategic goals, enablers, and outcomes, as the report published by the ICSM (2017) revealed, entitled Cadastre 2034.

Previous research by an initial literature review found that the implementation of the Geodetic Datum of Australia 2020 (GDA2020) for NSW with respect to Mercury Project Solutions (2018) report highlighted some factors and issues in GDA2020's implementation. There issues and factors may be relevant to the implementation of a federated cadastral system in NSW. Global case studies countries provided an insightful comparison to Australia. The research discussed dealing with multiple jurisdictions and integrating the cadastres into SDIs (Harvey, 2011). The research did not deal with the provide strategies or highlight specific issues and factors for national cadastral reform for Australia.

In this research project, the Australian legal and cadastral systems have been described and discussed. The research gap highlighted a need to develop a strategy moving forward. Despite rapid cadastral reform, 'strong historical foundations' (Dalrymple et al. 2003), regressive reaction of governments and institutions (Steudler 2014), and a lack of understanding of the significance of cadastral reform (Donnelly 2008), are impeding the implementation of a federated cadastral system in NSW.

The aim of this research paper is to explore, assess and analyse which are impeding the implementation of the Cadastre 2034 vision's federated cadastral system as set out by the ICSM in NSW.

## 2. LITERATURE REVIEW

### 2.1 Introduction

Over the past few decades innovations in technology have witnessed the amalgamation and management of systems from

one central location, resulting in efficiency gains and eliminations of redundant elements in the former models. The future culminating to a point of global centralisation which Cadastral systems are especially suited to. The Cadastre 2034 vision envisages a federal government managed cadastre under a unified legal framework, adopting common standards, policies, and guidelines, proving to simplify dealings with and management of the cadastral system and land administration, promoting trade, mining, and commerce on both global and local levels. Ensuring better protection of the environment whilst looking at the big picture (ICSM 2017, p. 27).

Clear understanding is made of the relationships between elements in a cadastral system by Grant et. al. (2018), further research was identified to:

- The legal status of Spatial Cadastres to be clarified.
- Investigate the best practice model as Spatial Cadastres are upgraded.

Grant et. al. (2018) mentioned that the legal role of Spatial Cadastres across jurisdictions in Australia varies. An impact on Spatial Cadastres in determining boundaries suggests that should there be a clear and concise legal role and status at the one level then reciprocally. Cadastral surveyors, and allied professionals, in each jurisdiction would benefit from a more amalgamated system. Current and past research on a closely related topic, 3-Dimensional Cadastre, in Australia reveals several issues requiring future research which relate to the research project aim. These issues are to do with legal frameworks in the implementation of 3D Cadastres, the approach to 3D Cadastres by the institutions and organisations, and issues in dealing with cross-jurisdictional boundaries (Ho et al. 2013, pp. 7-8).

On the international level a study into the cadastral reform of Seychelles revealed that reforming to the next level and embracing new technologies were not without their challenges. Sinon et. al. (1998) writes, '... it is necessary to review survey regulations to accommodate new procedures brought about by technological advances...'. This could also be applied to a federated cadastre in the sense that new technological advances which are enabling as they are in other countries require a review of the regulations and legal framework for future synthesis.

Kitsakis & Dimopoulo (2014) discuss the difference in Common Law and Civil Law on a global level in relation to 3D Cadastral titles and property. These two law jurisdictions are found in the Australian legal system as previously discussed. The article discussed in depth the differences, impacts and factors relating to mixed law jurisdictions. Though the qualities of the Civil and Common Law jurisdictions were framed over multiple countries no correlation was made to the implementation of a federated cadastre either internationally or in Australia.

## 2.2 The Australian Cadastral System

Unlike in most countries world-wide, the cadastral system in Australia is not a coordinated cadastre (Williamson 1994). Even though the majority of surveys are now required to be connected to State Survey Marks and Permanent Marks which have known Map Grid of Australia (MGA) coordinates (Williamson 1994), the reinstatement methodology of establishing and dealing with legal property boundaries spatially has not changed since cadastral surveying began in Australia (Dalrymple et al. 2003). Cadastral surveys are carried out to a high precision in Australia

and are treated as isolated surveys (Dalrymple et al. 2003), where a hierarchy of evidence based on a legal of principal of 'monuments over measurements' (Wattles 1969).

A Cadastral Model, lays its foundation on a geodetic framework upon which the land parcels are placed (Donnelly 2012). Then, the next layer is the register of land titles, previously this was kept for taxation purposes but now it is also used under the Torrens Title system to provide evidence of ownership and guarantees 'indefeasibility of title' (Donnelly, 2012). Further layers in the model assist in taxation, land use, planning and infrastructure, demographics, and environmental management. Government is the administrator of a cadastral model and sets policies, guidelines, standards, and legislation to properly and effectively administer the cadastre (Donnelly 2008). The current issue in Australia is that this system is administered by several different states and territories, and most local governments administer their own systems for their own purposes as well.

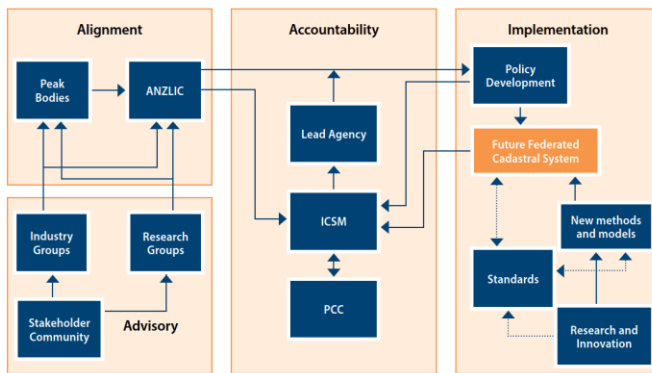
Moges (2014) found that though the Australian cadastral system had a good foundation, such as the Torrens system of title by registration, there were several limitations, namely:

- The cadastre was limited to the real property by land title;
- Institutional fragmentation; and
- No clear link between public lands and indigenous communities.

## 2.3 Cadastre 2034

Cadastre 2034 furthers the journey on from Cadastre 2014, facing new challenges that are anticipated over the next 20 years (ICSM 2017). While strategies and objectives were formulated as a national strategy for cadastral reform at the dawn of the Cadastre 2034 vision, heralded by Hirst (2014), an exacting study or how the implementation would work was not carried out. This study would be infeasibly broad as there are many facets within the field of cadastral systems, SDIs and multiple issues to deal with. Progressively the five goals have been researched, assessed and investigated to the application in a pragmatic approach for Australia. Extensive research has explored reference frames and coordinate systems, adopting GDA2020, and determining best practices for implementing 3D cadastres into both cadastral and legal systems. However, the implementation of a federated cadastral system has not been exhaustively researched.

Research has explored the comparisons between the states and territories in Australia as to the general context of the registration systems, policies, standards and guidelines (Donnelly 2008), which should be understood when determining strategies for a national synthesis. Spatial cadastre comparisons between the states and territories of Australia have shown that there are differing levels of spatial cadastres between them with recommendations working towards a common standard (Grant et al. 2018). Figure 2 shows where the federated cadastral system sits in relation to the stakeholders and what the stakeholders' roles are. The federated cadastral system is planned to build on existing systems in place, it is a matter how to integrate the SDIs of these systems harmoniously (ICSM 2017).



**Figure 2.** Federated Cadastral System stakeholder framework (ICSM 2017)

The legal profession has begun to realise the significance of Cadastre 2034. Griggs (2016) justified the importance of indefeasibility with respect to state guaranteed boundary positioning. It was argued that the RRR to land would not be practically achieved without a legally coordinated cadastre base on a national reference system. The resulting effect would be that the physical monument would longer to be considered primary method, first in the hierarchy of reinstatement. It may still have a place in a legally coordinated cadastre however the aim of which is to rely on state guaranteed coordinates.

#### 2.4 Uniform Torrens Title Act

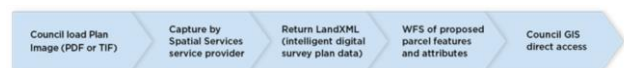
Synonymous with unification of cadastral systems in Australia is the initiative to uniform the Torrens Title system enabling a national system of title registration (Hunter 2010). Such a move faces many constitutional challenges. For unification of the Torrens Titling systems in Australia, drastic law reform must occur and be coordinated throughout all jurisdictions in Australia with their full support. The only way forward would be for the states and territories to allow a central government body to coordinate legislation and drafting of legislation to this effect, though the benefits of such a move have not been fully realised by the policy makers and have not been held a priority in law reform (Christensen & Duncan 2012). Perhaps a federated cadastral system may allow the unification of Torrens Titling system seem like a more practical, feasible and achievable task.

When the First Fleet arrived in Australia with both colonists and convicts aboard, they carried with them an integral part of England, English Law (Hallman 1973). In 1828, the Imperial Parliament in England gave NSW power to create its own laws by passing the Australian Courts Act (Imp), there was a provision in this Act that all laws and statutes in force in England on 25 July 1828 were also in force in NSW and Van Diemen's Land (Creyke 2018). The law was inherited from England, including common law. Then when each subsequent state and territory was formed, laws were inherited at that date they were formed, then the states and territories enacted legislations and statutes, and judicial decisions and judgements. The Federation of Australia in 1901 brought about another level of government, the Commonwealth of Australia. At that stage, there was no foresight or need in unifying legislation, policies and standards between the states and territories on what was considered to be matters for each state government, such as the Real Property Act or the Torrens Title Act, most of which were localised to each state's specific requirements (Creyke 2018). Now that SDIs of each government entity and most organisations are merely seconds away from each other thanks

to the internet, a realisation of a consolidated, central system for all is quite desirable.

#### 2.5 The NSW Cadastral System

The NSW cadastral system exists over several government entities, particularly Spatial Services and Land Registry Services. Furthermore, the Board of Surveying and Spatial Information, the Surveyor General, Registrar General and the Valuer General hold a special interest in the cadastre and are an integral part of its operation and regulation in NSW. There have been initiatives by the NSW Government to streamline services such as LandXML data for new lot creation in Graphical Information Systems (GIS) from State to Councils, which each hold their own cadastre separate to the State (Spatial Services 2021). As can be seen in Figure 3, the streamline process initiative to assist Councils reduce processing time in their cadastre duplication.



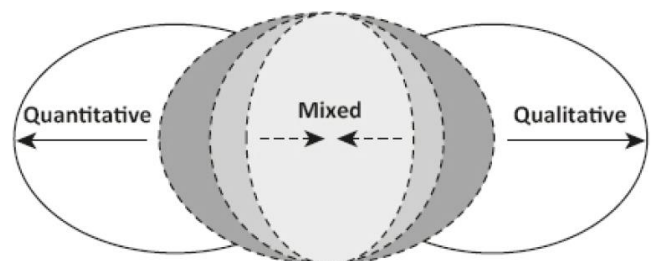
**Figure 3.** Streamline process of LandXML WFS (Spatial Services 2021)

This initiative is good and fit for purpose however with the right spatial data infrastructure (SDI) this could become obsolete with the possibility of a federated cadastre providing a centralised solution.

### 3. METHODOLOGY

#### 3.1 Mixed Methods Design

Qualitative and quantitative research was required in a mixed method research (MMR) project to complete the research objectives. MMR installs credibility towards the research (Human Research Ethics Foundation 2019). MMR builds on the strengths of multiple methods avoiding limitation and diminishing weakness as opposed to a single study approach (Andrew & Halcomb 2007). As illustrated in Figure 4, MMR combines both Qualitative and Quantitative research to draw conclusions, the weight may be more towards one or the other though the idea is to reinforce the analysis with validation.



**Figure 4.** Illustration of mixed method research (Clark & Ivankova 2017)

The MM design framework adopted for this specific research question was interpretive and sequential. There are two phases to the design: one exploring and validating the key factors and issues affecting the adoption of a federated cadastre; and the second assessing the behaviours and strategies to determine the readiness of NSW in adopting a federated cadastral system. The framework design, shown in Figure 5, has been adapted from the typology shown by Cameron (2009). The typology was built

on and expanded to fit the research question. The notations used in the framework design were adapted from Morse (1991), establishing a standard of MMR design notations widely used in academia.

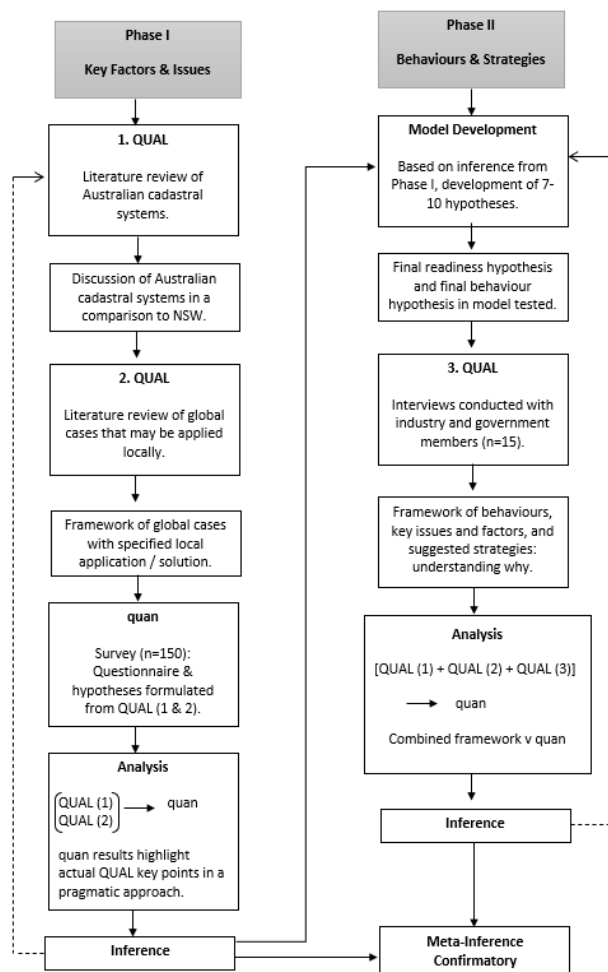


Figure 5. Mixed methods design framework

## 3.2 Methods: Phase 1 – Key Issues & Factors

### 3.2.1 Literature Review

A comprehensive literature review was undertaken to fulfil research objectives and identify research gaps. A review on completion of the literature with the supervisor was required to ensure that future steps in this research project were relevant and any changes required were made early on to ensure success. Hypotheses were developed in an analysis model; each hypothesis related to a question in the questionnaire. This research project was limited to 10 hypotheses as more than 10 was not feasible and would have required a larger sample size due to more degrees of freedom in the partial least squares-based structural equation modelling (PLSSEM) analysis.

### 3.2.2 Case Studies

Drawing on the initial findings of the literature review, research was undertaken to find countries which matched could each provide insight on the implementation of cadastral reform and

new policy acceptance particularly focusing on countries with a collaboration of subordinate cadastral systems such as a federated cadastral system. This was not a strict requirement; lessons may be purported regardless of exact circumstances (Yin 2014). The findings were then framed in a tabulated format to contribute to the next sequence in the MM design.

### 3.2.3 Questionnaire Survey: Human Ethics & Data Collection

A HRE application was completed prior to sending the questionnaire and conducting the interviews. A questionnaire was formulated to fulfil objective 3 based on the literature review. The questionnaire was sent out to 215 industry and government participants, 3 of which opted out though 71 completed the surveys. The questionnaire consisted of five questions with two items each. Each item addressed two aspects of each hypothesis statement. In Table 1 there is listed 5 hypotheses statements under factor/issue categories, these hypothesis statements were proved against a true and false scale to highlight, key to factors and issues.

Factor/Issue	Decision Criteria (Hypothesis Statement)
Organisational (O)	Political vision ( $O_v$ )
	Institutional leadership ( $O_l$ )
Information / Data availability (I)	Cross-jurisdictional reciprocity ( $I_j$ )
	Information & data system ( $I_s$ )
People (P)	Member cooperation ( $P_c$ )
	Member self-education ( $P_e$ )
Access network (A)	Legislation, policies, guidelines, standards ( $A_l$ )
	Technological infrastructure ( $A_t$ )
Financial Resources (F)	Government funding ( $F_g$ )
	Private sector activity ( $F_p$ )

Table 1. Decomposition of factor/issue categories of SDI readiness into decision criteria Adapted: (Delgado et al. 2005)

The scale was set from ‘1’ being strongly disagree to ‘7’ being strongly agree based on a seven-point Likert scale.

The questionnaire survey was completed after the Human Ethics application approval from USQ. Demographics were also collected however the scope of this research did not warrant a deeper analysis into each demographical opinion or behavioural analysis.

### 3.2.4 Questionnaire Survey: PLSSEM Analysis

SmartPLS 3 software is a structured equation modelling software package equipped with many analysis calculations over latent variables using data such as survey data (Dijkstra & Henseler 2012). The partial least-squares (PLS) model was used to calculate path coefficients indicating the enhancement or regression towards a particular hypothesis statement (Hair et al. 2017). The latent variables (LV) scores after the PLS algorithm have been run over the model. The connections between the LVs are indications of agreement towards the hypothesis and the scores on the LVs for the purpose of this research indicates the readiness for that variable (Fornell & Larcker 1981).

Based on the SmartPLS software guidelines and tutorials the hypothetic model was formed, as shown in Figure 6. Data representing the yellow input boxes were linked to the csv and then processed accordingly using both PLS and bootstrapping algorithms.

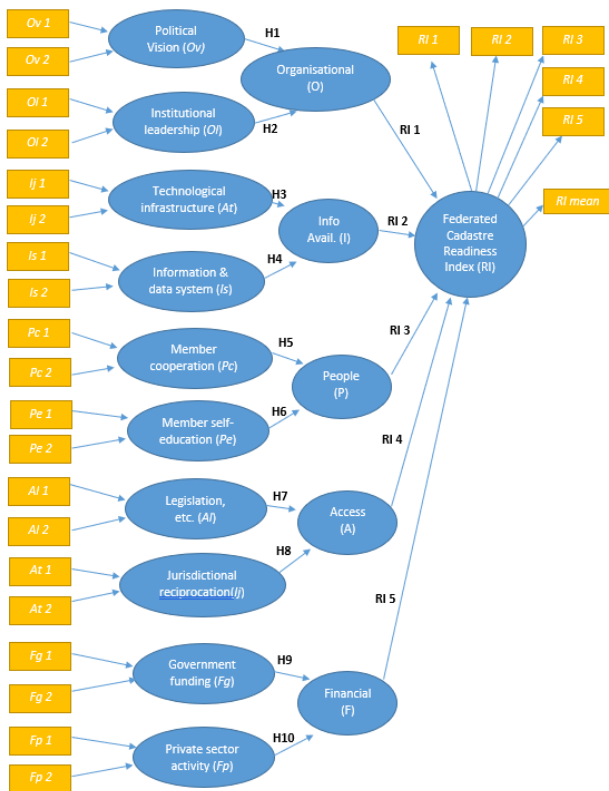


Figure 6. PLSSEM analysis hypotheses model – initial readiness index

### 3.3 Methods: Phase 2 – Behaviours & Strategies

In anticipation of the interview the hypotheses and related strategies were developed and added to the hypothetic structural PLS model as shown in Figure 7. Proposed strategic corrective values were inserted into the model to understand the effect of proposed strategies on the readiness index and was further explained in the analysis section of this research project.

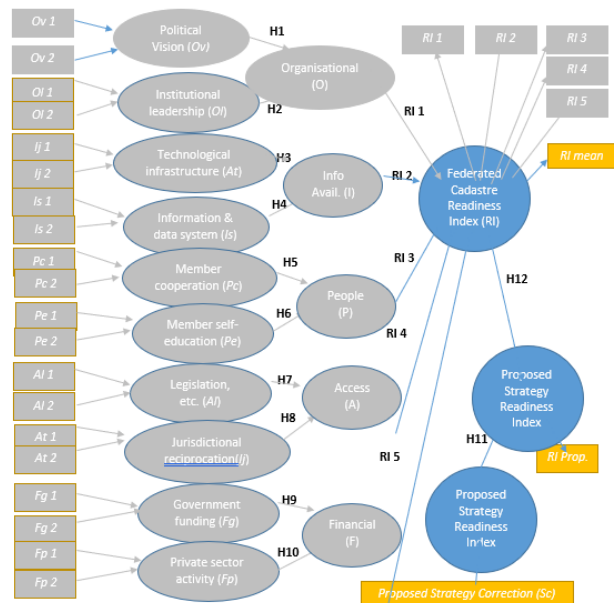


Figure 7. PLSSEM analysis hypotheses model – proposed strategy correction

Semi-structured interviews were conducted with 9 participants. The purpose of interview was to understand why the key issues and factors existed and how best to resolve them. The participants were contacted by e-mail before the interview. The interview guide was developed based on results of the survey. The interview guide was pilot-tested with a member from each demographic and changes were made accordingly. The time was fixed and interview was conducted through zoom & by mobile phone. The permission was taken for zoom recordings. The Transcripts were coded independently before inserting data on software. The quantitative analysis from interview outputs was used to verify the findings. MMR worked well in this research, enhancing and highlight issues more deeply and concisely than just mere quantitative research (Clark & Ivankova 2017).

## 4. PHASE I – KEY FACTORS & ISSUES: RESULTS & DISCUSSION

### 4.1 Literature Review & Case Studies: Purporting Applications

The literature review and case studies have been discussed in previous sections. The key issues and factors have been categorised and questionnaire statements have been developed. The applications are being tested by a community of professionals from both public and private sector. These questionnaire results reveal the behavioural inclination for or against statements which in sections 6 are deliberated on in the form of hypothesis statements and associated strategies. The results of which were discussed in the previous sections 2 & 3.

### 4.2 Questionnaire Survey Results: SmartPLS

The questionnaire responses were exported from the online USQ survey tool platform and imported into the model in SmartPLS based on the model shown in Figure 7. The results can be seen the latent variables for the categories of Organisation and Access hold significant values. The path coefficients reveal that the member readiness values, and the access readiness values are significant regressive factors.



### 4.3 Readiness Index

The overall readiness index in a PLSSEM analysis was compared with after the strategic hypothetic value is applied for each proposed strategy and the prevalent strategies recommended. Figure 8 showed that the main categories Organisation and People hold very low values, these are the areas of concern for strategy development (Rujikietkumjorn, 2015).

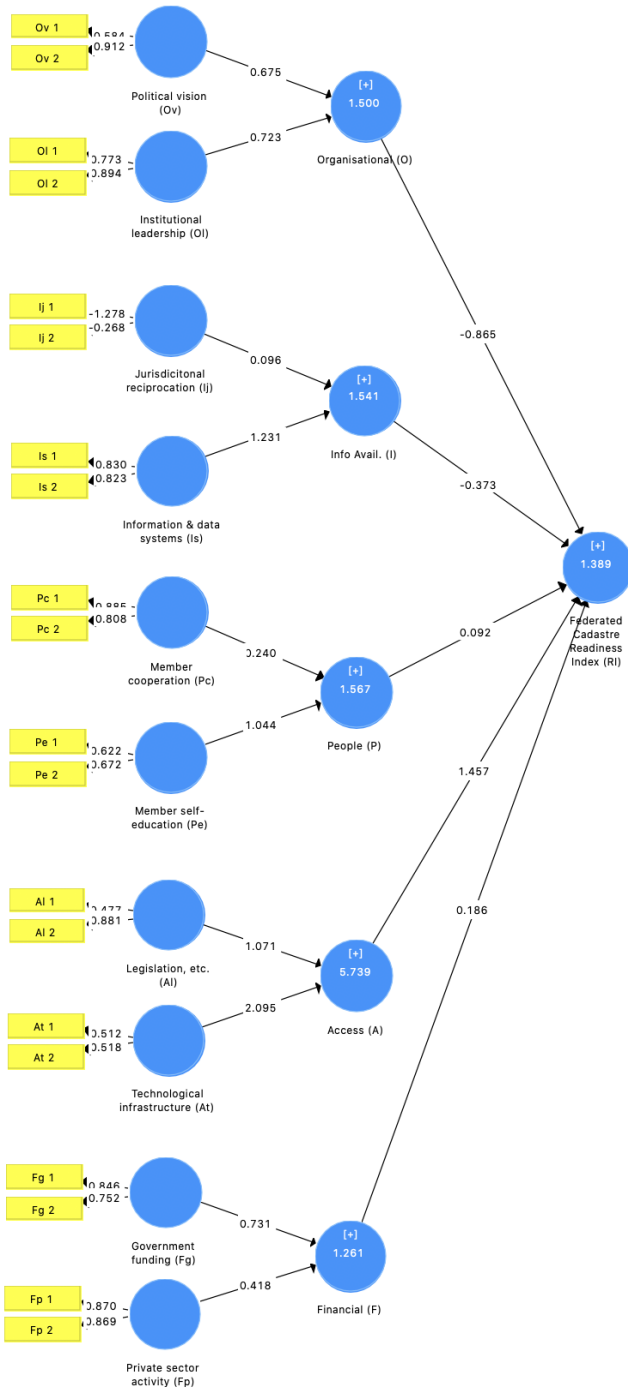


Figure 8. SmartPLS federated readiness and hypotheses results

### 4.4 Key Issues and Factors Identified

The three key issues were identified as follows:

- Government funding & privatisation.
- Institute & Professional Affiliate roles into the future.
- Stakeholder acceptance & readiness.

As illustrated in the Figure 8, one of the key issues was the sustainable funding. The involvement of private sector or public private partnership would resolve this issue. Part of the NSW Land Registry Services (LRS) is now privatised that operates the land titles registry on behalf of the NSW Government under a 35-year concession.

The second issue was there was a lack of leadership at a federal level when implementing a federated cadastral system in Australia. Consultation and involvement of professional bodies to develop national standards and policies to better facilitate the goals of Cadastre 2034.

The path coefficients resulted in negative values for stakeholder acceptance & readiness indicating regressive attitude towards the hypothesis (Rujikietkumjorn 2015). With these key issues and factors identified, the development of hypotheses for strategic readiness was worked on in support of the interview framework analysis.

## 5. PHASE II – BEHAVIOURS & STRATEGIES: RESULTS & DISCUSSION

### 5.1 Strategic Readiness Hypothesis

The following strategies were developed from the hypotheses for possible implementation and reanalysis in the hypothetic model:

- H1: The NSW Government should lead the way in this reform.
- H2: Allow the professional bodies to become an integral part of the new federated cadastral system and at the same time they may represent the stakeholders to ease concerns of change and alleviate the survival reaction.
- H3: Cadastre 2034 should develop a mechanism to allow reciprocal legislation, regulation, etc, creating and implementing updates in a cross-jurisdictional manner, perhaps a dynamic framework system.
- H4: An interjurisdictional committee could advise on unifying datasets and formats.
- H5: There should be clear stakeholder engagement to alleviate concerns for change and rather show the benefits.
- H6: Education of the stakeholders in the proposed mechanisms of Cadastre 2034 should be discussed in a forum allowing stakeholder input.
- H7: NSW Government should draft legislation carefully and in cooperation with other jurisdictions both reciprocal and subordinate.
- H8: A clear roadmap is required to be developed of how technological infrastructure would be best managed and utilised.

H9: Possibility of privatisation for funding should be considered for an effective strategy to solve this issue.

H10: Open access with private sector stimulates economy and allows for a better enabled society.

### 5.2 Strategic Readiness Hypothesis

Initial tests on each strategy with a proposed strategic readiness value in the SmartPLS SEM revealed that the following strategies performed well according to readiness index values:

H1: The NSW Government should lead the way in this reform.

H4: An interjurisdictional committee could advise on unifying datasets and formats.

H7: NSW Government should draft legislation carefully and in cooperation with other jurisdictions both reciprocal and subordinate.

The testing was limited in this research and future research is warranted on this part for further elaboration.

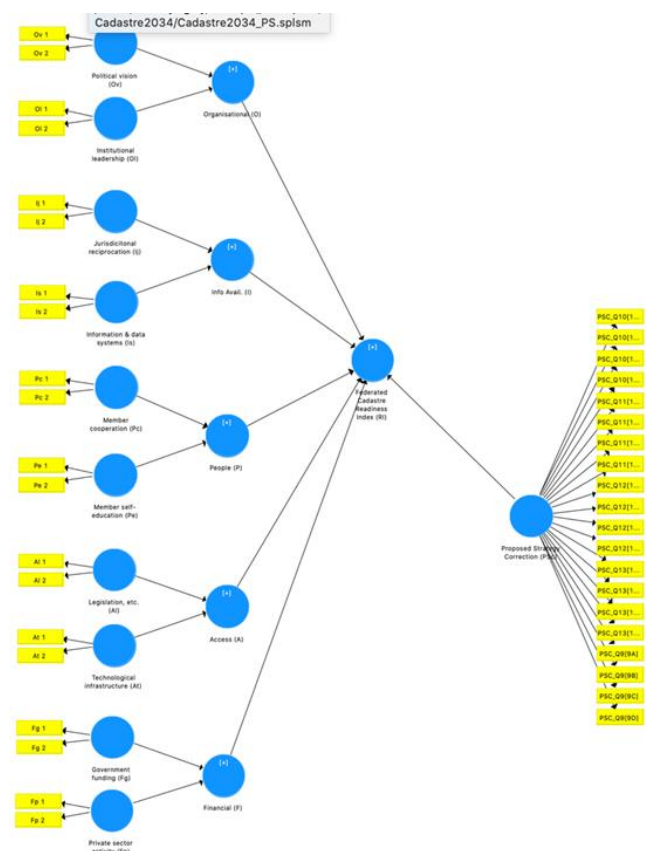


Figure 9. SmartPLS – proposed strategy correction resulting at 0.987 R<sup>2</sup>

The proposed strategies were entered into a csv file rated as either 1 or 7 from the Likert scale depending on if that hypothesis was hindering or enhancing Cadastre 2034 in NSW. Neutral fields having no change were rated as 4. The proposed strategic hypotheses were inserted and reanalysed in the hypothetical structural model were H1, H4 & H7, as stated above. The resulting readiness index was 0.987 R<sup>2</sup>, which according to Ahmed, Sultan & Williams (2021). This is a strong indicator of adoption of the certain policy, in this case a federated cadastre.

A weak R<sup>2</sup> value is considered 0.19 or lower, a substantial value is more than 0.67 (Ahmed, Sultan & Williams 2021). Therefore, the resulting value of 0.987 affirms the proposed strategies as effective from a behavioural science perspective. Whether the strategies are effectively implemented leaves scope for further research.

### 5.3 Interviews with NSW Cadastre Stakeholders

A broad cross section of NSW Cadastre stakeholders was interviewed to validate the SmartPLS 3 SEM strategic readiness results. The effecting proposed strategies were compared with “on the ground” reactions in an open-ended interview scenario. Excerpts have been listed of the interviews is presented in Table 2, as adapted from Roberge-Dao et al. (2019) methodology and result presentation.

Key Issue	Excerpts from interviewees
Spatial Accuracy	A federate cadastre should aim to provide positional uncertainties for data in the cadastre which are also survey accurate and reliable.
Data accessibility	A federated cadastre should adopt an open data model to promote access and usage.
Jurisdictional challenges	Multi-jurisdictional cooperation with legislation is near impossible and has basically been ruled out.  A Commonwealth entity should be responsible for the oversight of the States & Territories to ensure legislation is harmonious between the jurisdictions, after all we are all Australians.
Standards Integration	I don't imagine it is too hard to adopt the same standards in Australia between the States, it would just require some compromise or adopting a good cross-section of standards.
Member self-education	People generally are opposed to change, this is a touchy topic and surveyors wouldn't want to change the way they have been doing things, tried and proven methods.
Professional Affiliations	This is the first we are hearing of Cadastre 2034 however the notion has been discussed before but interestingly we have not been approached or consulted with on the subject and yet have one of the largest member bases nationally.

Table 2. Results of the interviews with NSW cadastre stakeholders

The key excerpts as highlights from the interviews have been listed in Table 2 against the key issue that it relates to, there was much more discussion, suggestions and recommendations which have been used in working out Table 3.

## 6. META-INFERECE CONFIRMATORY RESULTS

The meta-inference confirmatory results have been tabulated and presented in Table 3. This assessment of proposed strategies seeks to prioritise the findings of this research in a combination of the effect of the proposed strategy on the readiness index and combined with an importance weighting derived from the interviews to result in a score, the score is scaled from 1 to 5, and was calculated using the standard assessment matrix. The calculation of the importance weighting was by an extrapolation from Table 3, though adopting the lower of multiples.

Proposed Strategy	Readiness Index Effect	Importance Weighting	Overall Score
Central body dedicated to federated cadastre regulation and standardisation	High change of readiness index	Medium	4
Central body to manage federated cadastre	Low change of readiness index	Low	2
Central body for licensing	Medium change of readiness index	Medium	3
Unification of existing systems	High change of readiness index	High	5
Legally coordinated cadastre	Medium change of readiness index	High	4

Table 3. Proposed strategies assessment matrix

As derived from the last stage in Phase II of the MMR Design Framework, the recommended strategies for a federated cadastral system in NSW are:



- A legally coordinated cadastre;
- A central body dedicated to regulating and standardising the federated cadastre; and
- Unification of existing systems.

## 7. CONCLUSIONS

A federated cadastral system in Australia is not without its challenges though it would not be an impossible task. There are several hurdles to overcome on the way.

Firstly, as identified in the literature review, the reluctance to deviate from historical methods and practices are impeding cadastral reform. The hesitation in this respect is towards a proposed move from the long adopted methodological cadastral boundary reinstatement to a legally coordinated cadastre. The former mode of reinstatement is at common law in which its methodology is derived, and that later requiring to establishing new statutory provision in each jurisdiction, synonymous and set out from the one Commonwealth entity, to enable a legally coordinated cadastre moving forward into the future. As the profession and land titling offices are moving more and more to digital lodgements, records and transactions, it makes sense that the surveying profession moves in the same direction.

Secondly, there was found a lack of leadership at a federal level when implementing a federated cadastral system in Australia. A proactive approach is required, consultation with professional affiliations and inclusive workshops are recommended strategies to better facilitate the goals of the ICSM's Cadastre 2034. Further to the above, a full-time national council would be advantageous, and somewhat essential, in ensuring that the goals of Cadastre 2034 are met to the full expectation of the public and the profession. A part-time committee is a good start however the resources required in such an endeavour, as learned from the United States, requires dedicated federal oversight.

Finally, the surveying profession was surveyed and interviewed, it was found that there is an expectation and even a desire for a federated cadastral system to achieve uniformity and standardisation with leadership and central regulation. Lessons from the USA, Norway, Turkey, and Germany show that there while there is no perfect system, integration, standardisation and centralised management resolve national issues, and further Australia towards a global cadastre.

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