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Land Administration As-A-Service: Relevance, Applications, and Models

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Abstract: The 'as-a-Service' (aaS) concept of the IT sector is suggested to reduce upfront and ongoing costs, enable easier scaling, and make for simpler system upgrades. The concept is explored in relation to the domain of land administration, with a view to examining its relevance, application, and potential adaptation. Specifically, these aspects are analysed against the long-standing problem of land administration system maintenance. Two discrete literature reviews, a comparative analysis, and final modelling work constitute the research design. Of the 35 underlying land administration maintenance issues identified, aaS is found to directly respond to 15, indirectly support another 15, and provide no immediate benefit to 5. Most prominent are the ability of aaS to support issues relating to financial sustainability, continuous innovation, and human capacity provision. The approach is found to be already in use in various country contexts. It is articulated by the UNECE as one of four scenarios for future land administration development. In terms of adaptation, the 4-tier framework from Enterprise Architecture—consisting of Business, Application, Information, and Technology layers—is used to model and describe five specific aaS approaches: (i) On Premises; (ii) Basic Outsourcing; (iii) Public Private Partnership; (iv) Fully Privatised; and (v) Subscription. Several are more theoretical in nature but may see future adoption. Each requires further development, including case analyses, to support more detailed definitions of the required underlying legal frameworks, financial models, partnerships arrangements, data responsibilities, and so on. Decisions on the appropriate aaS model, and the application of aaS more generally, are entirely dependent on the specific country context. Overall, this work provides a platform for land administration researchers and practitioners to analyse the relevance and implementation options of the aaS concept.

Keywords: cadastre; land registration; information systems; SaaS; PPPs; FELA

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Citation: Bennett, R.M.; Donovan, J.; Masli, E.; Riekkinen, K. Land Administration As-A-Service: Relevance, Applications, and Models. *Land* **2023**, *12*, 241. https://doi.org/10.3390/land12010241

Academic Editor: Walter T. De Vries

Received: 13 December 2022
Revised: 5 January 2023
Accepted: 10 January 2023
Published: 12 January 2023

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1. Introduction

The concept of 'as-a-Service' [1] (aaS) is a well-founded approach in the domains of information technology (IT) and information systems (IS). It suggests a movement away from business and organisational models focused on delivering products at repeated and often ad hoc intervals, towards a service-oriented subscriber model [2]. Many traditional providers of IT software and hardware have moved towards the model, and it finds increasing use across other sectors [3]. The aaS approach is suggested to minimise upfront costs, reduce ongoing costs, enable easier scaling, and make system upgrades simpler.

The aaS model deserves consideration in the land administration domain, particularly in relation to the significant and longstanding problem of land administration system maintenance [4]. A land administration system collects, manages, and disseminates information, spatial and social in nature, about land tenure, land value, land use, and land development. In this work, the term 'land administration' is considered to encompass the terms 'cadastre' and 'land registry'. In many country contexts, significant effort is afforded to securing initial

funding and establishment of land administration systems; however, far less attention is given to ensuring the system is self-sustaining [5]. The result is that data in the system becomes outdated or parts of the system decay over time, resulting in wasted investment.

The concept of maintenance encompasses the updating of a land administration system with changes to people-to-land relationships (e.g., transactions), or the upgrading of data quality within the land information system in terms of accuracy of content, or the broader renewal of its underpinning IT infrastructure [6,7]. Whilst there exists a significant amount of literature on approaches to improve maintenance, e.g., [4,8,9] problems continue to persist in practice, e.g., [10].

Fundamentally, some of these problems are macro in nature, for example, relating to broader issues of public trust in government institutions, and may not be within the immediate gambit of land administration practitioners to solve outright [4]. However, where appropriate, practitioners should continue to explore alternative administrative approaches, particularly those developed in similar or related disciplines, such as public administration or IT. In this regard, it is the role of applied scientific domains to explore and report on these developments.

Therefore, to move the discourse beyond mere understanding of the 'maintenance' challenge and acknowledge recent work from the UNECE on scenario development for future land administration design c.f., [11], this paper explores the idea of applying the aaS approach to mitigate, transfer, or remove the maintenance problem. It should be noted that very few examples of published, independent, critical, and structured academic works exist linking aaS and land administration. A preliminary review of online academic literature repositories conducted as part of this work (see Section 6), combining aaS and land administration keywords, revealed only a handful of papers directly linking the concepts.

The overarching aim is to undertake a critical exploration of the aaS concept in terms of relevance, application, and potential adaptation to the domain of land administration, and specifically maintenance. The results can provide a platform upon which land administration practitioners and researchers can assess, pilot, and refine the approach.

After this introduction section (Section 1), an overview of the applied methodology is provided in Section 2. A 4-step research design is described. It consists of two separate literature reviews (one on the 'land administration maintenance' problem and the other on the aaS solution); a comparison of the outputs of these reviews; and a final fusion or synthesis phase. The results of each step are presented independently in Sections 3–7. An overall preliminary understanding of the relevance and utility of aaS is arrived at in Section 8, the conclusion section, which provides an overarching summary and suggested areas for further work, for both practical and research domains.

2. Materials and Methods

This work sits within the pragmatist research paradigm, closely linked to design or engineering research. That is, this work seeks to assess whether the aaS conceptual solution has validity for the domain of land administration, and if so, how it might be adapted or implemented within the domain.

There exists minimal works directly linking the aaS and land administration concepts (see Section 1, Introduction). Therefore, rather than undertaking or reporting on specific pilot studies or cases, this work must begin first from principles to identify foundational concepts on aaS and land administration maintenance, sitting in disparate bodies of academic literature, and then seek to combine those concepts. For this, the methodology of 'research synthesis' [12] is used. This involves setting the bounds around a relevant body of literature, reviewing it in a structured fashion, and assembling the findings to form a novel contribution. The approach is used widely across many domains, including land administration, with justification and specific examples provided in [4,13–18]. In the context of this work, it needs to be noted that the research synthesis methodology is limited in that it only captures published applications and cases. Other applications of aaS linked to land administration may exist in practice. Therefore, whilst the body of analysed literature may be considered comprehensive, it may not reflect

all applications occurring within the sector. That said, this work may act as inspiration to empirically capture other cases of aaS application.

For this work, two overarching components exist with regards to the exploration: (i) relevance and (ii) application and/or adaptation. To use the method of research synthesis to achieve the demands of the 2 components, a research design of 4 interlinked steps was conceived (Figure 1). This was because, as already mentioned above, there exists very few works directly linking the aaS and land administration concepts. Therefore, the two previously disparate bodies of literature were first analysed in terms of maintenance problems and aaS solutions (Step 1 and 2). This enabled a comparative analysis of problems against solutions (Step 3), and finally synthesis/modelling (4). The 2 bodies can be described as 'land administration maintenance' on the one hand, and 'aaS' on the other. The process for reviewing each body is first explained, and then the comparison and fusion processes are outlined.

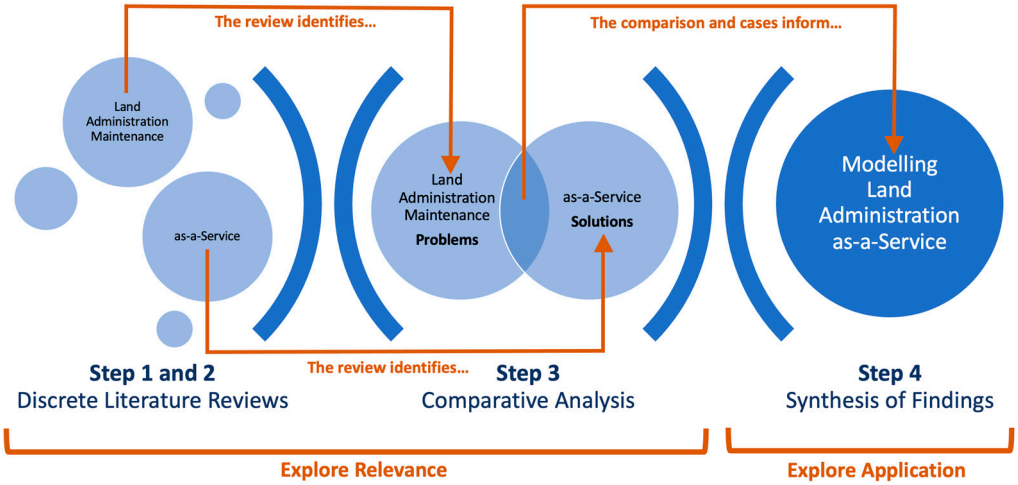

Figure 1. Research Workflow.

The 'land administration maintenance' review (Step 1) work is presented in [4]. The literature search and review procedure are fully presented in that work. In summary, (i) a review period between January 1990 and December 2020 was justified; (ii) searchable repositories included Scopus, Science Direct, Google Scholar, the OICRF website (International Office of Cadastre and Land Records), and standard Google searches (i.e., to enable incorporation of relevant grey literature); (iii) search strings and combinations included 'maintenance', 'update', 'upgrade', 'renewal', 'land administration', 'cadastre', 'land registry' and 'fit for purpose'; (iv) snowballing [4] determined the constellation of relevant papers; and (v) analysis and reporting were chronological. The summarised results of [4], *relevant to this work*, are presented in Section 3. These include a contemporary definition and a categorisation of the major problems relating to land administration maintenance.

For the aaS review (Step 2), a similar process was undertaken. The concept is newer than the land administration maintenance issue, with initial searches suggesting it originates in the mid-2000s. As such, to ensure completeness, the epoch January 2000 to December 2020 was initially selected. The same search repositories were utilised as per the 'maintenance' search. The aaS concept is a cross-cutting or cross-disciplinary concept, and for this review all aspects of the concept were considered relevant; the search repository approach enabled this cross-disciplinary analysis of the literature. Search terms included 'as a Service' and 'aaS' and extensions such as: 'Software as a Service' or 'Saas'; 'Infrastructure as a Service' or 'Iaas'; 'Data as a Service' or 'DaaS'; and 'Everything as a Service' or 'EaaS'. As mentioned, these terms were also searched in combination with land administration terms (i.e., registry, cadastre), and 'government services' more generally, to identify any pre-existing work on overlaps in the domain. Similar to the 'land administration maintenance' concept, the results were first analysed and reported chronologically. Special attention was made in this analysis to identify the key characteristics of what constitutes

aaS from business, management, and technical viewpoints. Additionally focused upon were enabling conditions, advantages, and disadvantages of aaS. The results of the review are presented in Section 4, covering the definition, drivers, designs, the problems aaS intended to solve, and the benefits of aaS. The aaS is outlined as a theory and model, and state-of-play examples from other sectors are provided.

To complete the 'relevance' exploration, a comparative analysis (Step 3) was undertaken. Key features of the aaS solution were logically mapped against the 'maintenance' problems, as identified in [4]. The mapping involved using the results of both literature reviews from Step 1 and 2, making direct comparison between problem and solution, and identifying the benefits of aaS against the problems of land administration maintenance. Identified were the major challenges and opportunities relating to land administration maintenance, against the characteristics, enabling conditions, benefits, and disadvantages of aaS. Essentially, this provided an initial overview, if not suitability assessment, of the potential utility of aaS in land administration, and specifically in response to maintenance problems. The results are presented in Section 5.

For the exploration of 'application' (Step 4), the results were compiled descriptively. Inputs included results from Step 1–3, and analysis of any further literature identified already demonstrating efforts to combine land administration and aaS. The results are presented in Section 6. The analysis then more deeply considered the potential application of aaS in the context of land administration in terms of contextual requirements, potential benefits realisation, and probable implementation challenges. These results are presented in Section 7. Use was made of the existing models of aaS to guide the analysis. This modelling work also led to the identification of further research in terms of (i) further confirming the findings and refining the characteristics and requirements of each of the aaS models via more nuanced case studies on specific land administration systems, and (ii) piloting and assessing the approaches within a jurisdiction. The results of this work are presented in Section 8.

3. Recapping the Maintenance Problem

A contemporary overview of the maintenance problem (Step 1), along with attempts to understand it and suggested solutions, is provided in [4]. The review covers over 100 academic works from over a 70-year period, although primarily since 1990. An overview of the key findings relevant to the aaS analysis is now provided.

First, the review demonstrated that the land administration maintenance problem is long documented. In the 1970s–1980s, maintenance challenges were heavily motivated by the first forays into moving from paper-based manual systems to digital and automated systems. In the 1990s maintenance appears to have been a secondary concern to system establishment, particularly in post-Communist and emerging economy contexts. The 2000s placed more focus on 'systems' and 'socio-technical' understandings, although again, maintenance appears to have been a secondary concern. From the 2010s onwards, in the so-called 'fit-for-purpose' era, a more concerted focus on maintenance was apparent. That said, scaled implementations of fit-for-purpose applications were still seen to be struggling with ensuring adequate maintenance.

Second, the review meaningfully disaggregated the problem into several sub-elements (Figure 2). It defined key terminology and demonstrated the essential differences between those terms. In this regard, it revealed the potential for erroneous debates, whereby practitioners discuss different parts of the same broader conceptual problem. The disparity between 'upgrade' and 'update' provides a prominent example. The different challenges for 'spatial' versus 'rights' data updates provide another. Essentially, there is a clear need to distinguish between the day-to-day challenges of updating data, versus the longer-term strategic challenge of renewing entire systems. The latter is more likely to include aspects of institutional change, potential legal reform, and new financial models, alongside technology upgrades. The resulting taxonomy of maintenance problems assists in system diagnostics and resultant solution development. The framework can provide utility in the exploration of the aaS approach.

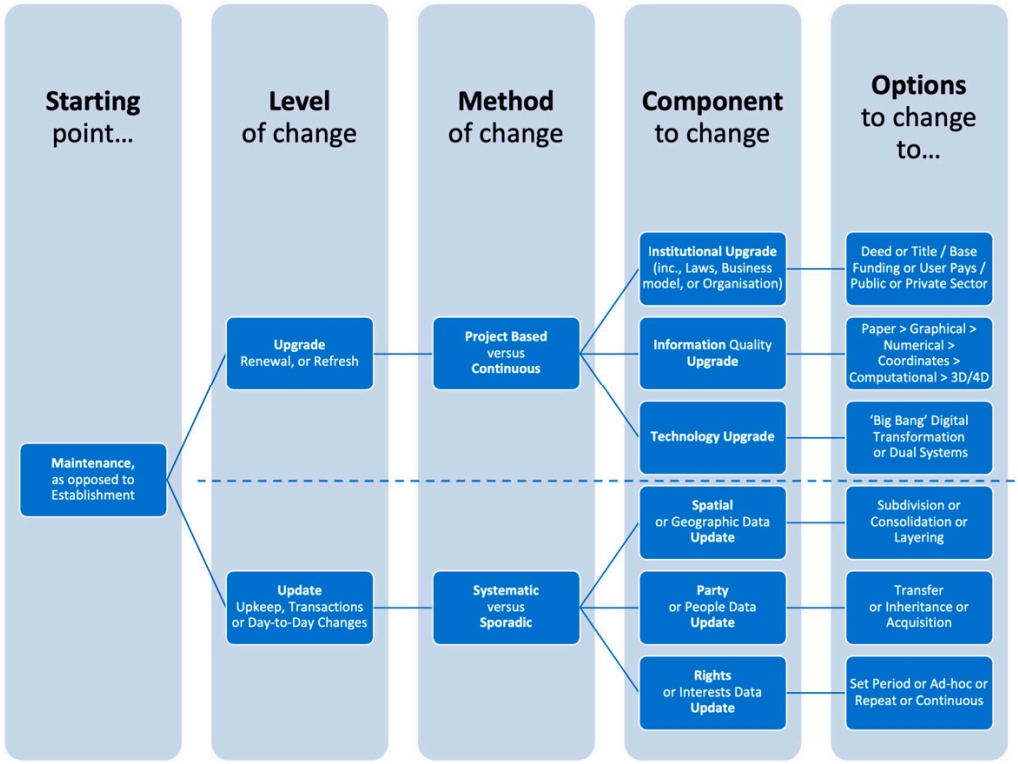

Figure 2. The overarching maintenance problem is an aggregation of many aspects and various terminology (source: [4]).

Third, the review also delivered an organising framework for the broad suite of solutions for maintenance issues. Here, use was made of the Framework for Effective Land Administration (FELA) report made available by the Expert Group on Land Administration and Management as part of the work of the United National Committee of Experts on Geospatial Information Management (UNGGIM) [19]. Solutions (and problems) relating to maintenance were classified under the following categories: (i) Governance and Institutions; (ii) Law and Policy; (iii) Financial; (iv) Data and Processes; (v) Innovation; (vi) Standards; (vii) Partnerships; (viii) Capacity and Education; and (ix) Communications and Awareness. The catalogue could assist in problem diagnosis of the 'as is' situation, but equally and more importantly, assist in the identification and selection of both responsible and fit-for-purpose 'to be' solutions. Again, the model's utility in understanding the applicability of the aaS approach is clear.

Fourth and finally, the review made clear that both the problem and solution spaces are dynamic and ongoing attention needed to be afforded to emerging trends. This included going beyond the land administration domain to identify new developments, be they related to institutions, law, finances, or technology, amongst others, or combinations of those. Developments relating to automatic feature extraction, cloud services, and cybersecurity concerns are mentioned. In this vein, the review justifies considering the aaS approach in the land administration domain, although it does not mention aaS specifically.

4. Unpacking 'as a Service'

Step 2 results revealed that the origins of the aaS concept, at least in the broad domain of IT, dates at least to the 1980s and 1990s. The author of [20] outlines the benefits and costs of the approach with regards to bug fixes, while [21] introduce the 'Software Service System' as a means of enhancing software use and marketing, outlining the need for supportive fee payment and IP management approaches. Further, [22] argues that issues of cost overruns and delay relating to software provision are due to the 'product' mentality, stemming from hardware provision, used in the industry. However, it was really in the late 1990s, due to

the exponential growth and uptake of the internet and IT outsourcing [23], that the software aaS concept gained more use and acceptance as a viable business and operational model, at least in terms of future industry development [24,25]. The general idea was that rather than paying for software as a product, at ad hoc moments and based on unpredictable market demands or opportunities, a business could enter a subscription service with a software provider, pay a regular fee or license, and receive ongoing enhancements and updates. The approach would have the dual benefits of ensuring a more regular income stream for software vendors, whilst also assisting in overcoming the persistent challenges of maintaining outdated software versions and software piracy, amongst others.

By 2008 the concept had mainstreamed: the 'SaaS' acronym had wide use across the IT industry as an exemplar service delivery method, being contrasted to COTS (commercial off-the-shelf software) [26], and with SOA (Service Oriented Architecture) acting as the commensurate software design approach [27]. The implications of the approach were examined from the business model, technical integration, and customer perspectives [28,29], amongst many others [30,31]. By 2010, the perhaps more marketer-friendly 'cloud' terminology (i.e., including 'web services') had somewhat overtaken aaS in mainstream software marketing, as optic-fibre cable networks, if not prolific Wi-Fi networks, and low-cost data storage, enabled the realisation of higher bandwidth internet services [32].

From 2010 onwards, the aaS moniker was transferred across all parts of the IT spectrum, spawning 'Data as a Service' (DaaS) [33][1], 'Infrastructure as a Service' (IaaS), 'Platform as a Service' (PaaS) [34], and the somewhat less useful 'Everything as a Service' (EaaS) [35], or 'Anything as a Service' (XaaS).

The approach also proliferated in mainstream consumer markets with the extension of the internet service provider (ISP) subscription model, usually based on a monthly fee, which translated successfully into the media and entertainment domains, thanks to Web 2.0, most prominently including services such as Spotify, Apple Music, Amazon Prime, and Netflix, and the mobility market (e.g., Uber One or Uber Pass). The impact aaS might have on transportation and the disruptive socio-economic flow on effects were explored [36] (i.e., MaaS). Whilst the approach's benefits were espoused, the socio-technical challenges of ensuring privacy, security, independence, and service quality also received attention [37].

Going even further, the potential adaptation of aaS was explored in the areas of machine learning (i.e., Machine Learning as a Service, or MLaaS) [38], and for evaluation of systems more generally (i.e., Evaluation as a Service, or EvaaS) [39]. At this point, one might question whether the term had merely become an overused—but presumably highly effective term for marketing departments—or whether the term had even been hijacked for pushing underlying political, if not philosophical, agendas. A well-known example of the latter is the World Economic Forum's '8 predictions for the world in 2030,' published in 2016[2], with one prediction being, "You'll own nothing, and you'll be happy," with the explanatory text going on to outline that by 2030 most individual needs would be provided as services, not as conventionally purchased products.

With the background development of aaS now provided, for the purposes of this study it is necessary to confirm what constitutes aaS in terms of definition, scope, and components. At the broadest level, the definition used here is: "something being presented to a customer, either internal or external, as a service" [40][3]. Interestingly, due to the broad use of the term across multiple disciplines and the mainstream, finding and selecting a standardised analytical framework for aaS is a somewhat fraught exercise. As shown above, it could variously include a focus or components on business model aspects, technology aspects, legal/policy issues, partnership approaches, concerns about data and standards, security aspects, service level agreements (SLAs), and so on. In terms of conceptual models, a large proportion of diagrams are simple infographic-like depictions with rudimentary, if not ill-explained, linkages between system components. Another common and perhaps more useful approach is to differentiate SaaS, IaaS, PaaS, and other 'aaS' by means of continuum[4]. These are usually technology-centric depictions illustrating the technologies and tasks the client organisation is responsible for, and those for which the service provider

organisation is responsible. However, these are more focused on business-to-business or government-to-government aaS service arrangements, and tend not to include the customer or citizen in terms of their responsibilities and technology requirements.

Taking the above into consideration, it is suggested that modelling approaches from the sub-domain of 'Enterprise Architecture' (EA) and 'SOA' provide a basis for aaS analysis [27,41]. EA forms the conceptual basis of many Enterprise Resource Planning (ERP) software implementations (e.g., using Oracle, Intuit, or Workday platforms) within organisations, with 2nd generation cloud-based ERPs c.f., [27–32] often themselves referred to as SaaS [42]. The EA concept is also known to the land administration domain, via the use of ERPs and Enterprise Geographical Information Systems (GIS) [43]. The underlying EA frameworks that support ERP implementations promote a whole-of-organisation (if not a whole-of-inter-organisational) approach and combine business aspects with technology aspects when it comes to managing the data and processes of an organisation.

Most of these EA frameworks include (at least) four (4) key layers: business, application, information, and technology. The business context includes the mandate to operate along with legal, organisational, and financing aspects. The application context includes the interfaces, transactions, or services undertaken with customers to enable delivery of their business needs. The information architecture includes the data, standards, and processes used to support the applications. The technology layers include the technology, hardware, and networks needed to capture, store, and disseminate information flows.

Applying aaS to this 4-layer framework, the different aaS models can be seen as on a continuum of transfer-of-responsibility, whereby there is a movement from full-on premises hosting and responsibility towards IaaS (where technology is off-site/sourced), to PaaS (information and databases are also offsite/outsourced), and finally to SaaS (applications also outsourced) (Figure 3). The most appropriate model depends on the business context, considering the level of internal control desired and IT costs allocated. This is where appropriate design decisions and responsible implementations are needed. It should be noted that there are countless versions and variations of Figure 3 available, differing in the number of layers to manage and the variety of aaS models. Here, a highly simplified version is presented for illustrative purposes.

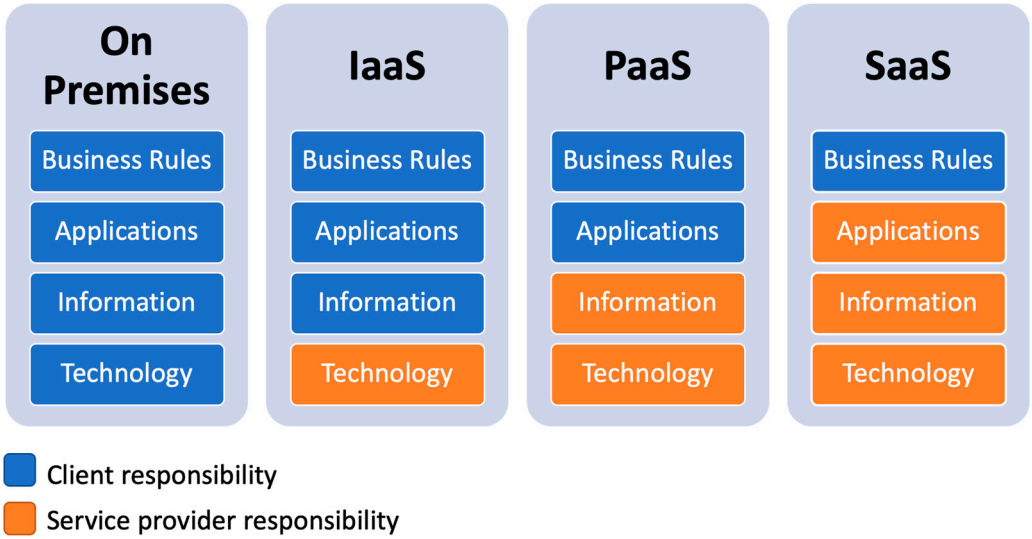

Figure 3. Common depiction of aaS with respect to EA layers (adapted from: https://www.redhat.com/en/topics/cloud-computing/what-is-saas, accessed on 12 January 2023).

In terms of the benefits aaS delivers or the problems it can support solving, summarising the above works, figures and [44], the following can be stated: (i) lower upfront costs; (ii) shorter lead times to initial benefit realisation; (iii) smaller on-going costs (on account of a shared or multi-tenant hosting environment); (iv) access to business-critical applications

anytime and anywhere (thanks to the cloud-based nature of aaS); (v) more straight-forward modification, tailoring, and updating of set processes; (vi) easier scaling of systems and cleaner integration of systems; (vii) improved or more responsive real-time support; (viii) simpler piloting and proof-of-concept delivery; (ix) great ability to introduce significant upgrades (i.e., paced and iterative); and (x) system redundancy, backup, and upgrading benefits.

Having provided an outline of aaS in terms of origins, definitions, components, and benefits, the subsequent section undertakes a comparison with direct reference to the land administration maintenance challenge.

5. Comparing for Relevance

The results of the comparative analysis (Step 3), based on the inputs of Step 1 and Step 2, are presented in Table 1. Here, an adapted version of Table 1 in [4] is used to present the comparison. It directly links the maintenance problems and the aaS solution. The specific problems relating to land administration maintenance are categorised under the 9 strategic pathways of FELA. In turn, the ability of the supposed benefits aaS to respond to those problems is assessed. Initially, this is presented as a simple 3-point Likert scale indicating whether aaS could provide direct response (D); indirect response (I) (i.e., a flow-on benefit or side effect of an aaS intervention); or no or limited response (N) to the specific maintenance problems. Whilst these indicators are considered self-explanatory, they are then further explained and justified with a textual description in the final column.

Table 1. Overview of land administration maintenance challenges and potential responses of aaS (adapted and updated from [4]; Note: D = direct response; I = indirect response; N = no or limited response).

FELA Strategic Pathway	Maintenance Problems (Adapted from [4])	aaS Response	Explanation (Stemming from [20–42])
1. Governance and Institutions	Land agencies have project focus rather than continuous improvement focus.	D	aaS enables continuous improvement, provided it is embedded in the relevant SLA.
	Land agencies only have a mandate for establishment (i.e., no clear mandate for upgrades exists).	N	On its own aaS does not establish mandates for upgrades, although it can help clarify roles.
	Land agency organisational resistance to upgrades from within, and external stakeholders.	D	aaS results in reallocation of upgrade mandates and incentives to external land sector actors.
	Conventions and traditions guide processes.	I	aaS demands a rethink of conventions and traditions.
2. Law and Policy	No developed adopted policy on updates or upgrades.	I	aaS might be part of a whole-of-jurisdiction policy development process for land administration.
	Failure to create laws for updating and/or upgrading.	I	aaS prioritizes moving towards digital data over paper in policy/law, and might be part of specific legal reforms on outdated legislation/regulations.
	Regulations for data capture are outdated or prescriptive.	I	aaS can support deregulation of maintenance requirements and actors involved.
	Implementation and enforcement of laws is not in place.	N	aaS does not ensure legal implementation and enforcement on its own.

Table 1. *Cont.*

	FELA Strategic Pathway	Maintenance Problems (Adapted from [4])	aaS Response	Explanation (Stemming from [20–42])
3.	**Finances**	Funding dependencies on allocated government budget (i.e., not self-sustaining).	N	aaS does not necessarily change underlying funding structures.
		Existing business models result in government losses.	D	aaS helps to reduce upfront and ongoing costs, and may result in new business model (e.g., pay-per use, yearly fees, subscription).
		Land agency 'rent seeking' behaviours.	D	aaS assists disrupting rent seeking behaviours by transferring responsibilities.
		Petty and/or grand corruption.	D	Digitalisation via aaS supports reduction in corrupt behaviours.
4.	**Data and Processes**	Analog data persists across spatial and party data.	D	aaS implies move towards digitalisation, e.g., via a scanning/digitising partnerships, data model development, and digital cadastre development (inc. 3D).
		Transactions remain paper-based/manual.	D	aaS involves business process redesign, and a move towards digitalization.
		New transactions are not recorded.	I	aaS can mean more responsive and broader coverage of service provision.
		Spatial updates are not made at all.	I	aaS can result in more frequent spatial updates, and use of imagery, feature extraction, and 3D/4D.
		Lack of quality of control over data processes.	I	aaS introduction may be accompanied with improved quality control procedures.
5.	**Innovation**	No innovation processes embedded to promote and enable change within land agencies.	D	aaS, via SLA, can assist embedding innovation and system renewal via continuous improvement.
		No promotion of entrepreneurship and/or innovation in the land sector.	D	aaS brings new actors into the land sector, fostering entrepreneurial acumen amongst land sector stakeholders, beyond land agencies.
		No existing IT infrastructure and/or technology blueprint.	D	aaS demands creation of IT infrastructure blueprint.
		Legacy IT infrastructure no longer supported.	D	aaS disrupts legacy IT infrastructure and can support development of parallel IT prototyping.
6.	**Standards**	Lack of standards on initial capture and maintenance.	I	aaS may be part of broader introduction of technical and managerial standards (e.g., OGC and ISO).
		Quality control and enforcement issues, even where standards do exist.	I	aaS may include quality and enforcement aspects, via the SLA.

Table 1. *Cont.*

	FELA Strategic Pathway	Maintenance Problems (Adapted from [4])	aaS Response	Explanation (Stemming from [20–42])
7.	**Partnerships**	Failure to create and maintain partnership networks (local, national, international).	D	aaS demands a focus on partnership building programs and a portfolio approach.
		Lack of inter-organisational processes at business, semantic, information, or technology levels.	D	aaS forces review and renewal of inter-organizational processes via mapping and redesign.
		Dependencies on other data providers.	I	aaS provides opportunity to revisit data dependencies.
		Prevalence of data silos among land agencies.	I	aaS process may involve breakdown of data silos.
		Poorly constructed or enforced public private partnerships (PPPs).	I	aaS provides opportunity for renewal or review of PPPs (but also risks creating them).
8.	**Capacity and Education**	Staff skills outdated or beneath required levels.	D	aaS makes more immediate availability of IT skills via service providers (although does not necessarily update internal skillsets).
		Educational curricula outdated in terms of theories, methods, and technologies.	N	aaS will not necessarily result in updating curricula, methods, and technologies in courses, although it could foster accreditation and professional development.
		Staff composition too static or too frequently changed.	D	aaS can enable or force staff restructures.
		Cross-border or cross-disciplinary 'brain-drain' in terms of IT/technical capacities.	I	aaS may further increase or decrease 'brain-drain' via outsourcing and offshoring.
9.	**Communications and Awareness**	Trust and awareness levels in public institutions are low amongst citizens.	I	aaS service provider may bring status and recognition, supporting the land agency via association.
		No engagement with processes and public services.	I	As part of aaS, marketing and communications can be reformed or even outsourced.
		No formalised communication plan or channels.	N	aaS does not directly improve communication plans or channels, but can be part of broader reforms, e.g., local pop-ups or one-stop-shops.

In terms of quantitative results, of the 35 maintenance issues identified in [4], aaS is suggested to enable direct responses or support in 15 cases, indirect or flow-on support in 15 cases, and no immediate benefit or response in 5 cases. In terms of specific FELA pathways, 6 of the 9 pathway problems are found to directly benefit from the aaS solution. Most prominent are those problems relating to 3. Finances and 5. Innovation. Others directly benefiting include 1. Governance and Institutions, 4. Data and Processes, 7. Partnerships, and 8. Capacity and Training.

A level of caution is required when reviewing Table 1. The comparison is based on a broad definition of aaS. As shown in Section 4, it can have quite narrow IT-related or broader system or inter-organisational meanings. It is important to state that the aaS benefits are only *potential* benefits, and may as yet be unproven in land administration practice. In some cases, aaS interventions may not produce the desired benefits and may even exacerbate problems of maintenance. Additionally, the appointment of indicator values, whilst helpful in providing an overall assessment of the *potential* relevance of aaS,

necessarily includes a level of subjectivity. Affirmation of these ascribed indicator values requires more data, quantitative or qualitative in nature, stemming from practical case examinations. As already mentioned in the Introduction (Section 1) and Materials and Methods (Section 2), limited in-depth published case applications exist, and the number of case applications in practice is unknown.

Limitations aside, the comparison suggests, as has been found in other sectors, that the aaS model may have utility in the land administration sector. That is, the results strongly suggest, at least from this initial overview, that aaS has high relevance. Accordingly, how (and whether) the aaS concept could be adapted and implemented in land administration practice is explored in the subsequent section.

6. Analysing Contemporary Applications

Until now, this work has not yet presented, at least in any detail, any pre-existing work exploring, applying, or combining the aaS and land administration concepts. As mentioned in Section 1 (Introduction), an initial structured search of online academic repositories, combining relevant aaS and land administration keywords returned very few relevant results (6). Within these, the aaS concept was often treated broadly, lacking specific definition, or a breakdown into analytical components. None of the papers dealt directly with an assessment of benefits and problems in relation to the land administration maintenance problem. That said, it is necessary to also examine these efforts at previous application within the domain. As already noted, beyond the preliminary search that motivated the work at hand, the relevant works also appeared again in Step 1 and Step 2 searches. To commence the aaS application exploration, the results are presented here.

Certainly, the concept of 'service' is well-known to land administration, land registration, and cadastres. As a somewhat invisible infrastructure (i.e., even boundary monuments are increasingly seen as redundant), surveyors and land administrators have long been at ease describing land administration as suites of 'services' rather than a distinct set of products [43–47]. In this regard, the era of digitalisation and its accompanying language has found much resonance in the domain. Even the advent of FFPLA has concentrated upon the use of the term 'service' [48]: the 2016 Guiding Principles [49] use the term no less than 140 times. Moreover, aaS applied to the broader domain of land management is realised through environmental protection interventions [50], ecosystem services [51], and organisations offering land management 'as a service' to companies as part of land rehabilitation [52].

That said, specific use or application of aaS—related to land administration, land registration, or cadastre—is far more limited, receiving some initial analysis or specific case examination in obscure or lesser-known works [53,54]. However, the domain is increasingly paying more attention to aaS. Referring to cloud, mobile, and big data technologies, [55] provides a vision for land administration systems becoming an 'as a service' platform. [56] reveal it as one potential aspect to support scaling up the use of Unmanned Aerial Vehicles (UAVs) more quickly within land administration (i.e., UAVs as-a-Service), from case work out of Rwanda, Ethiopia, and Kenya. The authors of [57] propose use of the SaaS concept as part of a Volunteer Rights-based Spatial Data Infrastructure (VRSDI) to support low-cost, faster paced land rights information capture in Iran. Generally, neither specific definitions nor overarching models of aaS are provided in these works.

Perhaps most extensively, the UNECE [11], later endorsed by FAO and FIG [58], identify 'As-a-service Land Administration' as one of 4 future scenarios for land administration in the UNECE region (Figure 4), based on mega-trend and driver analyses; the others being 'Conventional', 'Platform', and 'Distributed'. Driving the aaS scenario are issues around cybersecurity, open-data, artificial intelligence (AI), collaboration, and innovation incubators, amongst others. The aaS scenario would see more private actors engaged in land administration, although the approach would maintain the more traditional hierarchal governance arrangements (as opposed to a more decentralised or distributed setup). It would consist of defined services, process-orientation, appropriate regulation, data custodians and PPP arrangements. Examples

pointed to which are already in action included land registry privatisations in Australian States and Canada, and the provision of GNSS Continuously Operating Reference Stations (CORS) in some contexts. A useful set of guiding questions supports land administrators to identify whether the aaS may have relevance within a given jurisdiction. That said, as the report covers 4 scenarios, coverage of aaS is necessarily brief.

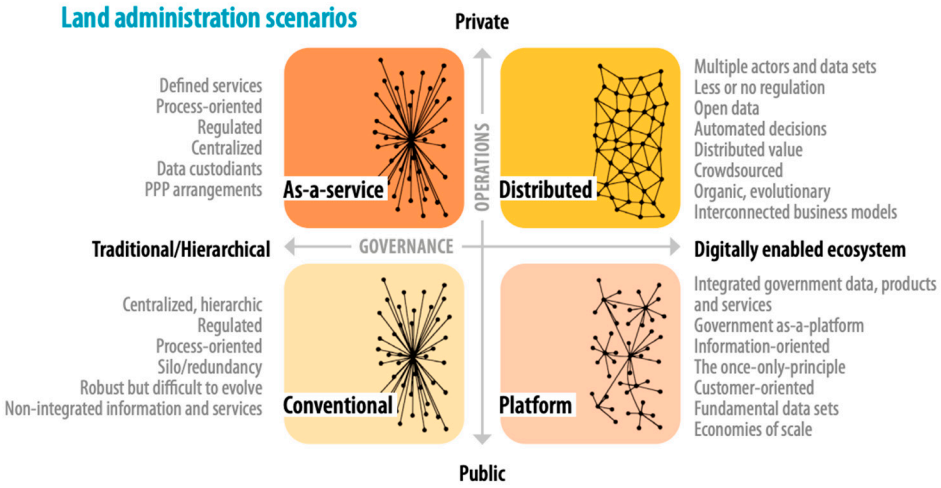

Figure 4. Land administration as-a-Service: one of 4 future scenarios for organising land administration, as defined by UNECE WPLA. (Source: [11]—from Scenario Study on Future Land Administration in the UNECE Region, by UNECE, ©2021 United Nations. Reprinted with the permission of the United Nations).

7. Modelling Land Administration As-A-Service

Taking the abovementioned (Section 6) first forays of aaS applied to land administration into account, and incorporating the results of Step 1–3 of this work (see Sections 3–5), a first attempt to develop a more detailed 'Land administration aaS' or 'LAaaS' framework is now presented.

As a fundamental starting point, for the purposes of this work, building from [46,59], land administration is understood fundamentally as an 'infrastructure' and 'public good'. Moreover, as outlined in Section 4, aaS analytical frameworks are often simplistic or overly broad, however, the baseline EA framework (i.e., Business, Application, Information, and Technology layers) was earlier identified as a potential starting point. Accordingly, it is used as the basis, with the intention to focus on adding aspects salient to the land administration domain. These additions are now explained.

First, three key actors pertinent to the domain of land administration are defined: (i) mainstream land agencies (i.e., government land administration authorities, cadastral offices, land registries, and/or mapping agencies), (ii) service providers (i.e., notaries, conveyancers, private surveyors, and IT outsourcing service providers), and (iii) customers or system users (i.e., land users, right holders, private, commercial, or public).

Second, five responsibilities and associated infrastructure components are defined: (i) business rules; (ii) applications; (iii) information; (iv) technology; and (v) transactions (or updates). The first four responsibilities build directly from EA frameworks [41]. The fifth responsibility—transactions—embodies the interaction between the land administration function and the system users of the land administration system. Transactions are usually triggered by a real-world land-related event (e.g., buying, selling, inheriting), but can also be more systemic (e.g., an annual land tax requirement and payment). Transactions are included as a layer primarily to help distinguish between the various aaS models (see below).

Subsequently, in combining the actors and responsibilities in different ways using the continuum approach, different aaS configurations are revealed. Figure 5 provides illustration. It shows five (5) generic models of aaS applied to land administration, each representing different responsibilities for the three types of actors in terms of business rules,

applications, information, technology, and transactions. As can be seen, each generally provides the contextual basis upon which to design and implement the subsequent layer. These are by no means the exhaustive components in the context of understanding and implementing a full aaS offering; each option would require study and analysis of broader land administration components including those from FELA, for example: (i) Governance and Institutions; (ii) Law and Policy; (iii) Financial; (iv) Data and Processes; (v) Innovation; (vi) Standards; (vii) Partnerships; (viii) Capacity and Education; and (ix) Communications and Awareness. However, it is suggested that the model provides a robust and tangible starting point for commencing analysis of the applicability of aaS in the context of land administration, within the scope intended for this paper.

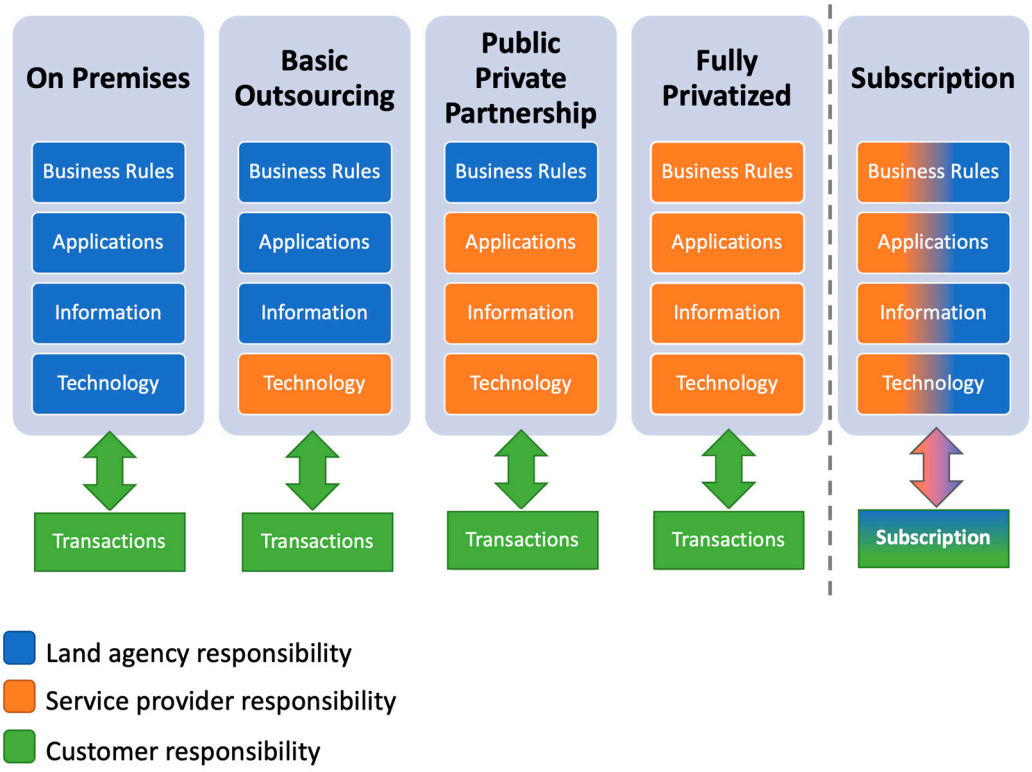

Figure 5. Options, actors, and responsibilities in aaS for land administration.

Reading left to right, the first of these, 'On Premises', is a conventional approach found in many jurisdictions, certainly before the advent of mainstreamed IT service providers. In this case, there is no role for external service providers: all responsibilities for technology and service provision are taken by a government ministry, department, or agency. This even includes surveying, mapping, and even notary/conveyance functions. Citizens instigate services by requesting transactions. This model persists in many jurisdictions, particularly emerging economies. The reformed land administration systems of Rwanda provide a prominent example. That said, the approach has been broadly in decline due to the rise of IT outsourcing, on account of the costs of IT, the opportunities delivered by cloud services and storage (i.e., commodification of IT), and the need to rapidly build data capture or IT development capacity (e.g., use of agents of the state).

The second case, 'Basic Outsourcing', depicts a conventional outsourcing arrangement, whereby IT infrastructure is provided by an external service provider. The business mandate, information, and applications remain in-house to the land agency. This might include computers, servers, internal networks, internet, cybersecurity elements, and so on. This model is sometimes found in jurisdictions where government has entered whole-of-government SLAs with technology providers (e.g., IBM and Fujitsu as examples). The model first gained prominence in the 1990s and 2000s on account of New Public Man-

agement ideologies. Many land administration systems in more developed contexts now exhibit this approach. The benefits and drawbacks of the approach are well documented in the IT literature.

The third case, 'Public Private Partnership', builds from the previous, however, more responsibilities have been transferred, usually to the private sector. There are many variations of this model, as disclosed by [60,61]. These stem from [62] and include 'Design Build', 'Operation and Maintenance Contract', 'Finance Only', 'Design, Build, Finance and Operate', 'Operate and Transfer', 'Lease, Develop and Operate', 'Build Lease', and 'Build, Own, Operate and Transfer'. Meanwhile, [63] provides another classification scheme including 'partial divestiture of public assets', 'joint venture', and 'full private sector divestiture'. For more conventional infrastructure (e.g., transport or communications networks), it is easy to appreciate that the model is focused upon the establishment and management of a tangible physical asset. For land administration, the approach becomes more abstract. A land administration system is made up of numerous components: adjudication records, survey control, boundary monuments, titles/deeds/certificates, survey plans, field notes, databases, face-to-faces offices, e-service platforms, and so on. Each of these elements can potentially become the subject of a PPP. This can include the holding of first rights of access to aggregate land transaction data. The Australian States of Victoria and New South Wales instigated such PPPs in the mid-2010s. In this regard, the model becomes more controversial: there are serious concerns regarding privacy and security of land record information, not to mention hidden and rising on-costs, especially after the initial financial gains for government are achieved. That said, there are certainly examples of where land data, particularly spatial data, is held and maintained by private entities. Indeed, there are many contexts—across most parts of the world—where private surveyors complete most of the cadastral surveying and hold (some) rights to the data. The Australian State of Queensland provides a prominent example.

The fourth case, 'Fully Privatised', represents a situation where the private sector controls land administration; government would play a minimal role, or no role at all. This is largely a fictitious case, but is analogous to customary or communally governed areas where governments may keep only rudimentary records, or not records at all. That said, in some contexts (e.g., some parts of countries in Latin America), there are cases where private sector agents are historically afforded a mandate to run a local land registry, make profits, and have little interaction with a provincial or central governments [64].

These first four models constitute the typical aaS relations of modern land administration systems. Where a specific country context sits on the aaS scale is a product of the citizen–government social contract, government policy, and financing issues within that specific jurisdiction. In terms of maintenance, these different models can be explored with regards to which setup would best enable a land administration to be kept up-to-date. Those jurisdictions that have found the appropriate model for local circumstances are also those jurisdictions that are able to maintain their land administration system. This is not to say that the aaS arrangement determines system maintenance success exclusively; it is more to say getting actor responsibilities and interactions clearly articulated and mandated is one essential ingredient, and one that perhaps many jurisdictions have not always gotten right. As a comparative example, in the Netherlands, Kadaster (the National Land Registry, Cadastre, and Mapping Agency of the Dutch), largely keeps responsibility for almost many components (Public), whilst in Canada (Ontario), and the Australian States, particularly Victoria and New South Wales, PPPs are far more evident in terms of transferral of responsibility to the private sector for technology, information, application, and even parts of the business layer[5].

Not mentioned until now is the fifth case, entitled 'Subscription'. This is a more novel aaS design, adapted from internet-based subscription e-service providers (e.g., media, communications). It is presented here as a concept, as to the best of the authors knowledge, no such cases exist in any jurisdiction. Certainly, the literature reviews underpinning this work revealed no such examples. That is, in practice this model cannot be said to be used

for the purposes of maintaining land tenure information. The only disclaimer on this statement is if the broader definition of land administration is used, incorporating land valuation, land taxation, or municipal rates levying/payment, be they annual, quarterly, or at some other set epoch. Although compulsory, these could be considered as a sort of subscription service (see [65] for more on the duration or temporal nature of various property rights, restrictions, and responsibilities).

Under the model, citizens, customers, or users of the system would pay a periodic subscription fee (e.g., annual) to the lead land administration agency or land administration service provider (public or private mandate is less relevant in this case and in Figure 5, therefore the elements are illustrated with half-half shading in terms of responsibilities) to ensure their land record information was updated and secured. The subscription fee would replace the transaction-driven approach currently in place in many jurisdictions. To explain further, currently, in most systems, changes to the land administration system occur when buying, selling, subdividing, or consolidating land occurs. Transaction fees and any duties are paid accordingly. These costs can be substantial and often disincentivise citizens to lodge in the official system, particularly in emerging country contexts. In the 'subscription' regime, such one-off fees would be removed: buyers and sellers would pay a subscription fee at a regular interval and undertake transactions as needed, with no extra fees per property registered (or at some graduated scale).

Such an approach would represent a movement towards a 'subscription' based land administration service. As said, it would be somewhat analogous to current procedures around municipal or local council rates, or utility service provision, paid by landowners/holders, to receive services to lands. In these cases, a slight difference is that users pay a flat service fee (or one based on the value of the property), but are then further charged atop for any resources used (e.g., water, electricity, extra garbage removal). In the subscription model proposed, this would not necessarily be the case, i.e., provided landowners pay a set fee, they can participate within the land administration system.

What would be the advantage of such an approach? Why would a jurisdiction or country bother? One should look to the growth of subscription services in other domains for the answers, and perhaps consider the oft-misrepresented *prediction*, as presented on the social media[6] of the World Economic Forum, that "You'll own nothing. And you'll be happy". First, spreading the fee base amongst a broader proportion of the population will result in lower fees, making the land administration system more accessible in the first instance. A challenge in many contexts would be getting that broad proportion of the population into the land administration in the first place. Second, the costs associated with buying and selling are greatly reduced; the reticence or apprehension to undertake a sale, using the formal system, due to the costs involved is reduced. Third, the model results in a steadier income stream or flow the land administration agency: it is less exposed to market forces with a guaranteed set of subscribers paying yearly or periodic fees, regardless of how often they transact. Combined, these benefits help to combat the data maintenance issues from Table 1. The approach responds to long-standing issues relating to system financing, failure to register transactions, and lack of awareness, amongst others.

That said, many questions remain unexplored with regards to the aaS subscription model in land administration. Amongst others, these include: (i) How do land administrators get the base set of subscribers established? (ii) What infrastructure is needed to ensure mass payment of subscriptions? (iii) What level would the subscription fee need to be? (iv) Would the system be voluntary or compulsory—and if compulsory, does the approach merely constitute another form of land tax? (v) If private sector plays an active role in providing the subscription services, does this move a system towards title insurance, and the increased costs for transacting parties, often associated with that model? Answering these questions is outside the scope of this work. The questions emerged as part of modelling work. They require further analysis to appropriately answer. Each would require the selection and application of the appropriate research method. That said, the approach appears worthy of exploration if it is potentially able to deal with the maintenance

issue. Finally, as already mentioned, each of the models presented in Figure 5 requires further articulation with respect to underlying requirements, design characteristics, and implementation approaches.

8. Conclusions and Future Prospects

In this work, the 'as-a-Service' (aaS) concept originating from the domains of IT and IS was applied to the land administration domain. Specifically, its relevance, application, and potential adaptation were assessed with reference to the well-documented challenge of failing maintenance in land administration systems. A 4-step research design, including two discrete literature reviews, a comparative analysis, and final modelling constituted the research design.

The review of the land administration maintenance literature revealed the issue was long recognised; that different understandings and terminologies have often undermined meaningful debate and solution identification; that the broader problem could be broken into 35 sub-problems categorised under the 9 FELA strategic pathways; and that land administrators must pay attention to emerging technical solutions.

The aaS review demonstrated the emergence of the concept and practice across many sectors from the 2000s onwards, thanks to the commodification of IT and the rise of low-cost internet services and storage. Benefits included reduced start-up costs, reduced ongoing costs, and perhaps most importantly for this work, easier maintenance and upgrade of IT systems.

In terms of the comparative analysis, of the 35 underlying land administration maintenance issues identified, aaS was found to enable provision of direct support to 15, indirect support to another 15, and no immediate benefit to 5. Most prominent were the ability of aaS to support issues related to financial sustainability, continuous innovation, and capacity provision.

With regards to any existing applications, the approach was found to be already in use in various country contexts and was supported by the UNECE as one of 4 scenarios for future land administration development.

Seeking to provide a more comprehensive model for aaS in land administration, the 4-layer framework from Enterprise Architecture—consisting of Business, Application, Information, Technology—was used to model and describe 5 specific aaS approaches: (i) On Premises; (ii) Basic Outsourcing; (iii) Public Private Partnership; (iv) Fully Privatised; and (v) Subscription. Several are more theoretical in nature but may see adoption in the future. Decisions on the appropriate aaS model, and aaS more generally, are entirely dependent on the specific country context. Overall, this work finds that the aaS concept has high relevance to the domain of land administration, and specifically the maintenance issue.

Areas for future research include identification and analysis of unpublished or recorded cases of aaS application within national or local land administration systems; quantitative and qualitative analysis of those cases against the various aaS models identified in this work; more detailed or refined articulations from legal, financial, and technical perspectives of each of the aaS models based on those case analyses, including costs-benefit analysis (and specifically the subscription model and the questions raised in the final paragraph of Section 7); and piloting of the models. Specific land administration transaction and services where aaS has more relevance could also be identified.

Author Contributions: Conceptualization, R.M.B.; methodology, R.M.B.; validation, J.D., E.M. and K.R.; formal analysis, R.M.B.; investigation, R.M.B.; resources, J.D.; writing—original draft preparation, R.M.B.; writing—review and editing, J.D., E.M., and K.R.; visualization, R.M.B. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data sharing not applicable.

Acknowledgments: The authors wish to acknowledge colleagues from practice and academia who read very early sections of this work, and encouraged us to move forward with applying the aaS concept to land administration.

Conflicts of Interest: The authors declare no conflict of interest.

Notes

1 Albeit already envisaged in 2002, and greatly motivated by the advent of 'big data'.

2 See: http://wef.ch/2gmBN7M (accessed 1 March 2021)

3 SaaS itself, and the other uses of 'aaS' (e.g., PaaS) tend to have more specific definitions.

4 For an example, see https://www.alibabacloud.com/knowledge/what-is-paas (accessed on 12 September 2021)

5 See: https://www.abc.net.au/news/2018-08-27/victoria-privatises-its-land-titles-and-registry-office/10169056#:~:text=The%20Victorian%20Government%20has%20privatised,up%20to%20the%20November%20election (accessed on 12 September 2021).

6 See: https://www.facebook.com/worldeconomicforum/videos/8-predictions-for-the-world-in-2030/10153920524981479/ (accessed on 12 September 2021)

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