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3D Geo-Information Innovation in Europe's Public Mapping Agencies: A Public Value Perspective

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Abstract: Intensifying and increasingly complex physical developments under, on, and above ground, as well as the speed and accessibility of digital innovation, is resulting in growing interest in public sector investment in 3D geo-information. In Europe, a consortium of 11 public mapping agencies (PMAs) recently undertook a cost-benefit analysis for pursuing adoption of 3D geo-information. However, broader public management literature has shown that while economic value is vital for justifying public investment, it is not the only driving factor and that the creation of public value is crucially and equally significant as it conveys social and political legitimacy. Using a public value perspective, this paper aims to re-examine the data collected by the consortium of PMAs. Content analysis of the qualitative data provides strong examples of how 3D geo-information may potentially manifest as different types of public value across a broad public of stakeholders as well as providing evidence that such innovation would likely be politically as well as operationally viable. Nonetheless, the lack of a clear obvious need for 3D geo-information that responds to a specific societal challenge may pose an impediment to successful innovation.

Keywords: mapping agencies; 3D geo-information; innovation; public value; public sector; Europe

1. Introduction

Maps have a long history in facilitating the creation of public value. In effect, they are argued to be an instrument of ‘modern statecraft’, providing the state with a way to ‘see’ through simplifying, standardizing, and codifying information about people and resources to deliver public tasks [1]. This has driven the establishment of public mapping agencies (PMAs), often at national levels, in many countries to support public organizations tasked with the production, management and stewardship of geo-information and associated products and services to meet a range of public interests associated with the economy (e.g., property, land use, mineral resources, infrastructure, etc.), the environment (e.g., soil type, topography, marine resources, etc.), and society (e.g., population distribution, health and safety, etc.).

To date, the synoptic orientation of public geo-information products and services has been two-dimensional (2D) in both perspective (i.e., terrestrial overview) and format (paper-based or analogue drawings). However, intensifying and increasingly complex physical developments under, on, and above ground, as well as the speed of digital innovation, is resulting in a growing perception that the 2D-based geo-information that PMAs provide are inadequate and at risk of delivering inferior solutions [2,3]. Over the past decade, there has been growing momentum in exploiting 3D digital technologies to produce 3D geo-information and related applications in the private sector and, increasingly, similar trends are becoming evident in the public sector. For example, a growing number of

countries are turning to the adoption of 3D city models for a variety of urban applications [4]. Figure 1 below illustrates several aspects of the growing value propositions associated with 3D geo-information, e.g., 3D city models, which enable a wide variety of urban applications ranging from 3D cadastre, noise propagation, and energy demand estimation to shadow estimation and solar potential analysis.

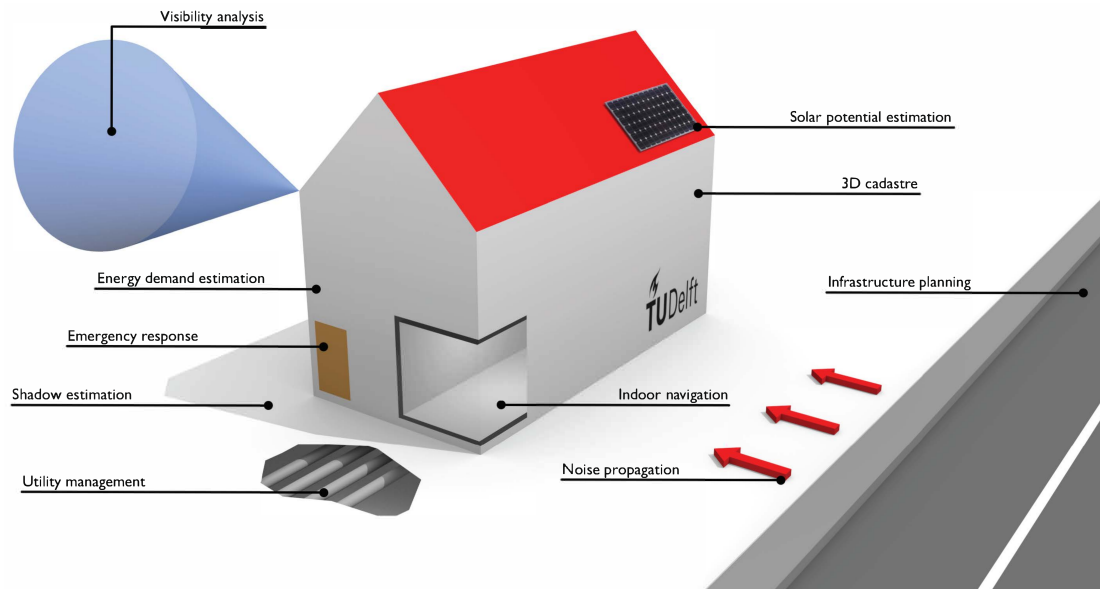


Figure 1. Potential applications of 3D city models [4].

These 3D innovations have been shown to deliver traditional public sector reform ideals around efficiency and effectiveness. Yet, such paradigmatic innovation undoubtedly costs time and money, not only in terms of the obvious investment in technical architecture, but, importantly, investment in building the required social architecture to facilitate change. With many governments now operating in a climate of budgetary constraints, the economic feasibility of 3D geo-information innovation (and corollary transformation of business and operating models) has been an understandable point of consideration.

Consequently, a recent project jointly funded and undertaken by 11 European PMAs under the auspices of EuroSDR¹ sought to quantify the economic value of digital 3D geo-information through a cost-benefit analysis based on six use cases. The study found that such innovation was potentially a viable return on investment (ROI), perhaps even profitable [5]. However, as other studies have found, while proving that economic value is vital for justifying public investment, it is not the only driving factor for transformative innovation in the public sector. Critically, the creation of public value (conceivably, a social ROI) is equally (if not more) significant as this conveys social and political currency [6–11].

A public value perspective on innovation exhorts public managers to seek to achieve not only the traditional innovation ideals of effectiveness and efficiency, but also important civic objectives like responsiveness to needs, liberty and participation, citizenship and transparency, etc., all of which contributes to, and reinforces, the legitimacy of governments [12–15]. In the domain of geo-information, we see evidence of this in how innovation is increasingly framed: the Copernicus program in Europe speaks of job creation [16]; a similar link between employment opportunities and the provision of public data and improved processes is expressed in the European Location Interoperability Solutions for e-government (ELISE) program²; the enhancement of elevation data in the United States is aligned

¹ EuroSDR is a not-for-profit pan-European organisation linking national mapping and cadastral agencies with research institutes and universities for the purpose of applied research in spatial data provision, management and delivery. It established in 1953 through an international treaty to represent the spatial data research interest of European countries (www.eurosd.net).

² https://ec.europa.eu/isa2/actions/elise_en.

with mission-critical objectives across all levels of government [17]; a similar initiative regarding making elevation data in The Netherlands freely available is discussed in the context of adding value to decision-making in other sectors like construction, infrastructure, energy, and planning [18]. Against this growing trend, the central question this paper is concerned with is therefore: what is the public value creation potential of 3D geo-information innovation for PMAs?

To address this question, we propose to use a public value perspective to re-consider the qualitative data collected during the course of the EuroSDR project through a series of stakeholder workshops across multiple countries. Following from this introduction, Section 2 will introduce the concept of public value, paying attention to the nascent literature on the public value of public sector ICT investment. In Section 3, the EuroSDR project is briefly described, before a review of the organizational missions of the 11 participating PMAs is undertaken to better understand and identify the types of public value creation emphasized by PMAs. Common themes around PMAs' intended public value creation and public tasks are identified and this, together with the literature review, is used to construct a framework to perform a content analysis of the workshop data (Section 4). Section 5 sets out the findings of the analysis where input from a broad range of stakeholders across multiple countries provides a sound basis to begin constructing the public value proposition of 3D geo-information innovation. The paper concludes with a discussion of the findings of the workshops in the context of the public value and public tasks associated with PMAs.

2. The Public Value Perspective

2.1. Conceptualising Public Value

The public value perspective is a public management framework commonly attributed to the public management scholar, Mark Moore, who argued that “the task of a public sector manager is to create public value” [19] (p. 296). At the time, his arguments countermanded prevailing neoliberal beliefs that democratic governments, and their managers, were passive actors in value creation and that public administration reforms were more about efficiency (in terms of service delivery) and effectiveness (in terms of experienced impact) rather than true entrepreneurialism [20,21].

Many have attempted to clarify what public value is (e.g., [11,22]). At the onset, Moore [14] had simply defined public value to be “rooted in the desires and perceptions of individuals” (p. 2), i.e., what does the public value, although he acknowledged that politics ultimately played a deciding role. Kelly, Mulgan & Myers [13] simply defined it as “the value created by government through services, laws, regulation, and other actions” (p. 4). Building on the relationship between user and provider, Meynhardt (2009) [23] defined public value as “any value defining the qualities of relationships between the individual and the public . . . impacting on how individuals or groups fulfil their basic needs” (p. 206). Similarly, Benington [24] supported a focus on the relationships between state, civil society, and individuals.

While there is some variation, these definitions reflect a fundamental belief that the impact of public services can only be assessed by users, and that users' preferences matter [25]. Hence, this preference- or value-based perspective, has a proactive element that warrants an expansion on the traditional view that governments only act (to provide services) when the market cannot adequately provide [6,13,26]. There is also a normative element in that democratically determined public preferences and government action reflect a communitarian approach to achieving a fairer society, not only for the present, but also with a view to improving future outcomes [6,24,27,28]. Kelly, Mulgan, and Myers [13] therefore argued that public value is constituted by what citizens most value, and include services (assessed by user satisfaction), outcomes (assessed by outcome targets), and trust, criteria which have been adopted by a number of scholars for analysis (e.g., [9,29]). A public value proposition is therefore about developing a strategy for an organization's activities that not only pursues traditional values around good governance, but more specifically focuses on matching tasks to specific issues which will enable the organization to better meet their public's expectations and desires [30].

Moore's initial proposition of public value is diagrammatized as a 'strategic triangle' of the following three related components (and ensuing trade-offs) (see Figure 2) [28]: legitimacy and support, operational capabilities, and public value. This serves to focus the attention of public organizations on the following three key questions: (1) is what we are delivering valuable?, (2) will the provision of the product or service be supported both by political masters and the community?, and (3) is the provision of the product or service achievable and sustainable? This helps to clarify the 'public value' an organization intends to produce, how this could be legitimized and supported, and what it would take to deliver this. Rhodes and Wanna [31] criticized the 'strategic triangle' for the uncertainty of its intended application, however, Alford and O'Flynn [26] argued that the triangle was useful in multiple ways including helping to clarify thinking about the objectives of public organizations (i.e., public value creation).

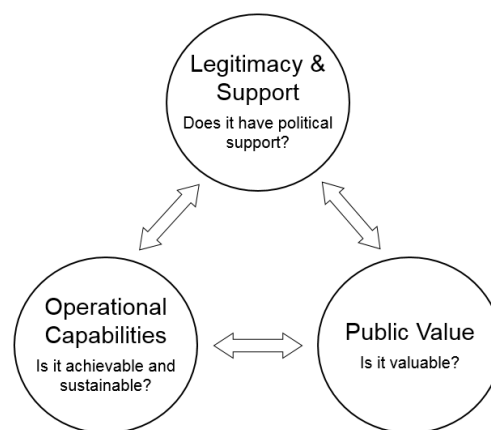


Figure 2. Moore's 'strategic triangle' for public value, adapted from [30].

Within such a conceptualization, scholars caution that the 'public' should not be thought of as a homogenous construct, but that public value must be differentiated across stakeholder segments [7,32,33]. This engagement is key to providing public managers with the broader political and operational authority to fulfil their public value proposition [30] (p. 591). Although delivering public value is seen to be a task that sits more comfortably with government [11], the diversity of needs, and how these can best be met, has meant that public value is equally applicable to other non-government organizations, which the public are dependent upon [21,34].

Public value also has its critics. Stoker [35] acknowledges that the inherent ambiguity of the concept poses difficulties in measuring public value. Hills and Sullivan [36] echo this difficulty, ascribing it to the complex causal nature of public value outcomes. There is also a tendency to confuse 'public value' with 'public values', both of which are normative; however the former has a utilitarian quality whilst the latter (e.g., see [6]) is used more in the sense of principles or behavioral standards commonly associated with public administration [30]. The concept also suffers from a limited evidence base that justifies public value conceptually and theoretically [22]. In addition, Dahl and Soss [37] caution that with the origins of public value being an analogy to private shareholder value, instead of countering the limits of neoliberal models of government in terms of individualism, democracy, and the free market, it may actually be further enabling these effects.

With its focus less on the individual and more on the polity, public value as a concept has resonated with governments, and is now a mainstream concept intrinsically linked with public sector reform, intervention, and innovation. This has particular appeal in the current milieu of complex political, economic, social, and environmental change [21,35]. Though commonly labelled a theory, public value is more accurately described as a holistic way of thinking about public management that is more than the traditional focus on effectiveness and efficiency. Recent thinking on the relationship between innovation and public value creation also suggests that defining a specific societal challenge that the innovation is focused on, can galvanize and direct innovation efforts, particularly across multiple sectors [38].

2.2. Public Value and Public Sector ICT Investment

Related to the paper's question, of concern is the literature concerning public value to broader public sector ICT investment. Although ICT investment has tended to be framed in terms of supporting public sector reform to achieve economic goals around performance, especially by Western governments [39–41], it is now recognized to be as much about improving socio-political objectives such as trust, transparency, and participation [42–44].

Due to the complex nature (in terms of scale, function, and stakeholders) of government ICT investment [45], the paradigm of public value as a way of validating investment is gaining interest, as is evident by the attention to conceptualizing an approach. For example, based on a number of case studies, Cresswell, Burke, and Pardo [7] developed a framework for assessing the public value return of ICT investment. They perceived public value as the intersection between stakeholders' (citizens') needs, government aims, and the promise of the ICT investment

Consequently, they framed public value in the following two ways: (1) as direct benefits to stakeholders and (2) directly benefitting government's standing as a 'public asset' (p. 2). They further argued for the following seven high-level public value types [7,32], with public value being experienced either directly or indirectly:

1. **Financial**—impacts on current or anticipated income, asset values, liabilities, entitlements, and other aspects of wealth or risks to any of the above.
2. **Ideological**—impacts on beliefs, moral or ethical commitments, alignment of government actions, policies or social outcomes with beliefs, or moral or ethical positions.
3. **Political**—impacts on personal or corporate influence on government actions or policy, roles in political affairs, or influence in political parties or prospects for current or future public office.
4. **Quality of life**—impacts on individual and household health, security, satisfaction, and general well-being.
5. **Social**—impacts on family or community relationships, social mobility, status, and identity.
6. **Stewardship**—impacts on the public's view of government officials as faithful stewards or guardians of the value of the government itself in terms of public trust, integrity, and legitimacy.
7. **Strategic**—impacts on economic or political advantage or opportunities, goals, and resources for innovation or planning.

Through a variety of case studies, the authors found that these public value types tended to be generated in four main ways, where public sector ICT investment results in improvements in [7] (p. 3):

- **efficiency**, i.e., reducing resource consumption
- **effectiveness**, i.e., improving quality of a "desirable thing" (e.g., particular good or service)
- **enablement**, i.e., allowing previously unachievable desired activity
- **intrinsic enhancement**, i.e., fundamental improvements to a stakeholder's operating environment or conditions.

Nonetheless, studies on ICT-related public value remain very much in their infancy, although there are some studies available, including on topics such as e-government [9,46–49], outsourcing [50]; and the emergence of frameworks to guide conceptualization, assessment, and evaluation (e.g., [7,32,49,51]).

3. The EuroSDR Project: Value of 3D Geoinformation

3.1. Project Background

The EuroSDR business case analysis project recognized the importance of establishing an economic rationale to support investment decision-making regarding the transformation of mapping agencies' business models towards one that transacts in 3D digital geo-information by default [5]. The project was undertaken between December 2015 and March 2017 and was a collaboration between

11 European PMAs (see Table 1). This was supported by an international consultancy specializing in geo-economics who worked with the participants to deliver the project's objectives. The project asked the following questions:

- In what applications does a 3D approach give added value?
- What are the required 3D data for these applications?
- What are the costs and benefits to collect and maintain these 3D data nationwide?

The PMAs deliberated on numerous potential use cases and finally identified the following six cases as the focus of the investigation (as listed in Table 1): forestry management, flood management, 3D cadastre and valuation, asset management, resilience, and urban planning. Data for each use case was collected and a value chain analysis was undertaken via workshops hosted by the PMAs that engaged with the main stakeholders for that sector in the respective country or countries. These stakeholders comprised representatives from public and commercial sectors who are active users and consumers of 3D geo-information such as tax authorities, emergency services, defence forces, real estate developers and/or property agents, insurance companies, and telecommunications companies.

Table 1. Participating European public mapping agencies in the EuroSDR study.

Jurisdiction	PMA Name and Abbreviation	Use Cases
Belgium	National Geographic Institute of Belgium (NGI)	Resilience
Catalonia	Institute of Geology and Cartography, Catalonia (ICGC)	
Denmark	Danish Agency for Data Supply and Efficiency (SDFE)	3D cadastre/3D valuation (shared with The Netherlands)
Finland	National Land Survey of Finland (NLS)	Forestry management
France	National Geographic Institute of France (IGN)	Flood management
Great Britain	Ordnance Survey of Great Britain (OSGB)	Asset management
Ireland	Ordnance Survey Ireland (OSI)	Urban planning
The Netherlands	The Netherlands Cadastre, Land Registry and Mapping Agency (Kadaster)	3D cadastre/3D valuation (shared with Denmark)
Poland	Polish Head Office of Geodesy and Cartography (GUGiK)	
Sweden	Swedish National Land Survey (Lantmäteriet)	
Switzerland	Swiss Federal Office of Topography (swisstopo)	Flood management (shared with France)

3.2. Mapping Agencies' Public Value

Since public value refers to the “value created by government through services, laws, regulation, and other actions” [13] (p. 4), this infers that the public value proposition is not only determined by stakeholders, it is also determined by the organization's mission and objectives. In this first step of the analysis, through publicly available materials (e.g., websites, annual reports, organizational strategy documents, etc.), we analyze the publicly stated services of the 11 PMAs.

Orienting the analysis in the context of the literature review in the previous section, we find that the organizational statements of the public mapping agencies support consistent themes around the types of public value created. Using the typology of ICT-related public value types outlined in the previous section [7,32] as an overarching analytical framework, we find reference to five of the seven types of public value in PMAs' mission statements. These public value types, and examples of how they are referenced in the mission statements, are provided in Table 2.

Table 2. Public tasks and proposed public value creation identified in the organizational missions of the participating PMAs.

Types of Public Value	Examples of Public Tasks Through which Public Value is Created by PMAs
Financial e.g., Finland, Ireland, Sweden	<ul style="list-style-type: none"> By maintaining administrative and spatial information about real estate transactions (including mortgages). This is required to create stable economic/investment conditions for building, developing, buying or selling of real property, and the building and development of national infrastructure. By developing/producing geospatial products and services for commercial purposes.
Ideological e.g., Britain, The Netherlands, Sweden, Switzerland.	<ul style="list-style-type: none"> By framing geo-information as fundamental public sector data, which government should provide for everyday decision-making, e.g., “informs, guides and inspires”, especially in support of sustainable development objectives. By performing and changing the nature of providing geo-information as a public task in line with the expectations of a knowledge-based society.
Political	<ul style="list-style-type: none"> Not apparent.
Quality of life e.g., Finland, The Netherlands, Sweden	<ul style="list-style-type: none"> By declaring its role in protecting legal certainty and security of property transactions through administration and management of land and property data. By broadly linking the provision of high quality spatial data and contributing to sustainable development objectives.
Social	<ul style="list-style-type: none"> Not apparent.
Stewardship e.g., Belgium, Britain, France,	<ul style="list-style-type: none"> By reinforcing the provision of up-to-date, comprehensive, definitive and authoritative geo-information as an important national-level service and reference source. By declaring its role in protecting legal certainty and security of property transactions through administration and management of land and property data.
Strategic e.g., France, Ireland, The Netherlands, Switzerland.	<ul style="list-style-type: none"> Through the development of new geo-information products and services to meet changing business, government and/or individual needs, which in turn, could provide economic advantage/opportunities. By providing advisory services, which could provide political advantage over planning, i.e., “first port of call” for spatial knowledge.

The statements suggest that public value tends to be indirectly created by, for example, better decision making and more secure conditions. In terms of value creation mechanisms, there is evidence for all four types:

- Improving effectiveness, directly related to mapping agencies’ stakeholders’ experience of mapping agencies’ products and services, e.g., “effective and efficient service to citizens” (Poland).
- Improving efficiency, this was often through the coordinating function of the PMAs such as “set up and manage a national documentation center . . . collect and disseminate information in a national database to coordinate the activities of public and private services” (Belgium), or reducing the transaction burden on citizens and organizations (e.g., Poland and Sweden).
- Enablement, e.g., “provide the public and private sector with high quality data that enables important social decisions to be made on the best possible basis” (Denmark).
- Enhancement, e.g., “collaboration with us supports the general public and the business sector in their everyday activities” (Sweden).

This review provides the basis of the framework that will be used to analyze the content of the EuroSDR workshops. Specifically, focus will be on the types of public value that appear key to PMAs’ organizational legitimacy and mechanisms through which public value impact is created. The approach is described in the next section.

4. Analytical Approach

The empirical analysis in this paper draws on the findings (specifically the qualitative data produced) of the use case workshops. While this paper is not intended to be comparative but simply exploratory, re-use of the data means that the objectives (understanding how 3D geo-information provides added value) and the assumptions (comparison of value lies in seizing opportunities

pertaining to the production and use of 3D geo-information versus what is currently available, i.e., not 3D) of the EuroSDR study are imported here.

In an initial review of the data, a high degree of overlap was found in the data produced in the asset management use case and other use cases in flood management and resilience, hence the outcomes of the asset management workshop were excluded. Of the remaining five use cases, four use cases collected data in the following similarly structured ways: identifying stakeholders (who stood to benefit), the process through which value is generated, and the actual benefit itself. This aligns both with a view to discovering what public value is perceived to be created (benefit), and how this value is being created (process). Consequently, the final four use cases used for data analysis in this paper are: flood management, 3D cadastre and valuation, resilience, and urban planning.

The data produced by the workshops³ took the form of short phrases or sentences provided by stakeholders, and the following are examples of such phrases:

“Less planning decision complaints”

“More accurate setting of price”

“Less complaints”

“Better visualization of developments”

“Putting the assets for disaster relief in the right place. More efficient allocation in planning leads to more effective response”

Given the exploratory nature of the main research question, interpretive thematic analysis was used as the main content analysis method. Thematic analysis is a way of organizing qualitative information around “codes” or themes to support pattern recognition and to characterize the intrinsic elements of the data [52,53]. In this research, two cycles of content analysis were undertaken [54], as illustrated in Figure 3. The first cycle relied on a deductive approach to coding the data using themes derived directly from the literature and the analysis of PMAs’ mission statements. Thereafter, a second cycle of inductive analysis process [55,56] was used to further understand the various aspects of those themes in this specific context (i.e., use of 3D geospatial data). In the second cycle, the codes and resultant categories are continually compared, revised, and refined to reduce overlap and to organize a hierarchy of descriptive categories deemed to represent and explain the theme adequately. Validity of the process relies on following the principles of data manipulation, which include categorization, abstraction, comparison, dimensionalization, iteration, and refutation [57]. Coding was performed using the RQDA software and was undertaken such that phrases or words were only assigned one unique code. This enabled the use of the count of code incidences as a comparative indicator to quantify the consensus around potential types of public value creation.

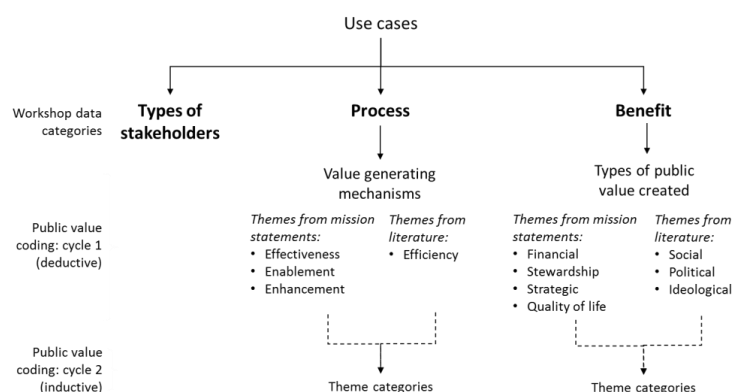


Figure 3. Two-cycle coding process for content analysis of EuroSDR workshop content.

³ Data reported under ‘benefits schedule’ in the cases described in Annex B of the EuroSDR report [7] (pp. 37–125).

5. Findings

5.1. Types of Stakeholders

Workshop participants identified more than 50 types of stakeholders across the four use cases. Of these, there were more public sector stakeholders identified as beneficiaries of 3D geo-information, which could potentially be interpreted as conveying downstream benefits to the community at large as well. After accounting for duplications and removing stakeholders that were too generic (e.g., “Government”), there were 28 unique stakeholder types identified as benefitting from investment in 3D geospatial data, where 11 of these were public sector stakeholders, 14 were private sector stakeholders, and three stakeholders could be classified as either (i.e., undifferentiated). This is shown in Table 3.

Table 3. Unique stakeholders identified cross four use cases.

Stakeholder Type	Identified Examples
Public sector stakeholders (11)	Crisis management group, Defence forces, Emergency services, Mapping agency, Municipalities/Local authorities, National Road Authority, Nuclear regulator, Office of Public Works, Public transport network, Public water authorities, Tax authority
Private stakeholders (14)	Aviation, Citizens, Construction industry, Data acquisition companies, Entrepreneurs, Geospatial industry, Insurance companies, Media, Property developers, Property managers, Real estate appraiser, Software companies, Solar panel vendors, Structural Engineering Consultancies
Undifferentiated (3)	All data suppliers, Telecom companies, Utilities

Public sector organizations that were identified were almost all those who had some form of direct territorial (including water) administrative responsibilities (e.g., defence, road authority, public works, public transport, water, etc.), or whose public tasks were dependent on territorial and/or environmental information (e.g., mapping agency, tax authority, emergency services, etc.). Private sector stakeholders were more diverse and were spread across a wide range of industry segments, indicating potentially widespread support for public investment in 3D geospatial data. Key beneficiaries were mainly those stakeholders related to physical development (e.g., property developers, insurance companies, property managers, engineers, etc.).

5.2. Potential Public Value Created from 3D Geoinformation

The deductive analysis demonstrates how stakeholders in the EuroSDR workshops perceive how 3D geo-information could lead to various types of public value being realized. To compare the strength of stakeholder consensus around the types of public value creation across use cases, we have used the code frequency as an indicative quantifying instrument. The distribution of strength of consensus is shown in Figure 4.

Financial value appears to be the public value type most commonly perceived to be created from the use and application of 3D geo-information across the various use cases. This public value type featured most significantly in the urban planning use case. Different types of financial public value that were identified included:

- Better administration, where resources such as people and time were used more efficiently, leading to cost savings. A potential disadvantage that was identified by stakeholders as a consequence of such efficiency gains was the possibility of job losses in the public sector.
- Better analysis and decision-making, including improved accuracy (e.g., more accurate setting of price), less variation in analysis, higher quality interpretation of the data, new analytical opportunities (e.g., assessing carbon footprint and retail viability, better valuation models). Such improvements were perceived to result in quicker and more accurate analytical outcomes (linking back to ‘better administration’). The downstream effects of improved outcomes could

also result in reduced liability costs (e.g., from better urban planning decisions), minimizing the cost of new infrastructure, and reduced future mitigation costs (e.g., by preventing development in areas without adequate flood defenses).

- Better data procurement, use and management, mainly associated with lower data capture and acquisition costs, lower processing costs, and less duplication.
- New financial opportunities, new 3D models, new business-to-government data supply, new sales, but also less directly through improved investment (from having better data and development analysis), more jobs, and the potential development of new markets due to increased use of 3D data.

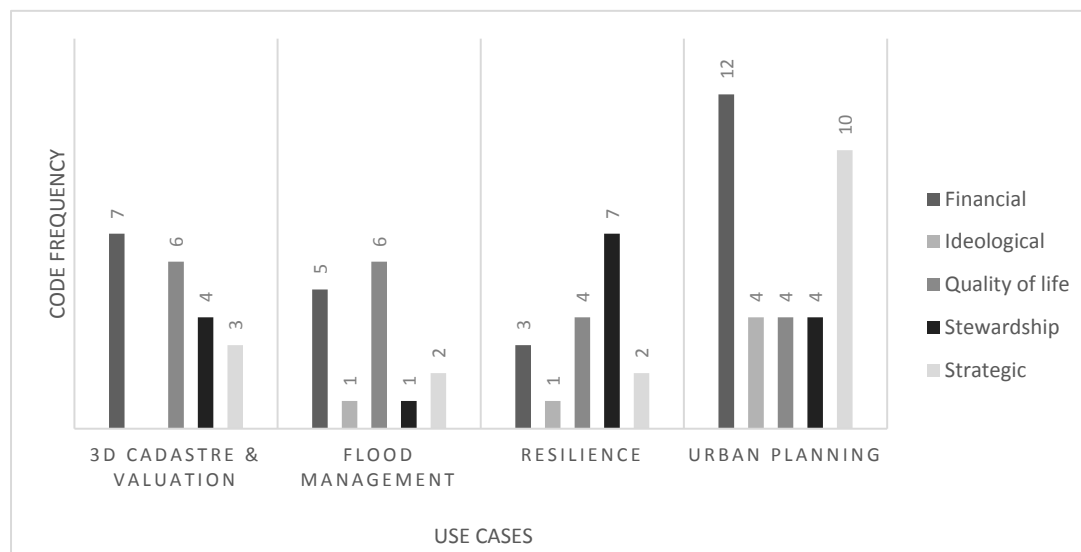


Figure 4. Types of public value distributed across the use cases.

Ideological value was mainly associated with the opportunity that 3D geospatial data provides to meet environmental commitments and management responsibilities. Again, this was most prominent in the urban planning use case.

The strength of consensus around quality of life value as a public value type was homogenous across the use cases. It was mainly a consequence of the improved and new analytical abilities afforded by 3D geo-information across the different use cases. This was seen to potentially improve public safety (prominent in the flood management and resilience use cases), stemming from being better able to protect citizens and emergency responders in times of disaster and terrorist incident response events as well as reducing the impact on infrastructure and businesses. There was an element of user satisfaction associated with improved analysis, e.g., pertaining to local planning (better information, less complaints, and reduced litigation), and a heightened sense of security, especially relevant to property transactions. Finally, this public value type was also attributed to an improved sense of well-being, due to the public sector being better able to realize environmental benefits.

Stewardship value was manifest in stakeholders' perceptions of 3D geo-information representing a better quality of public services, evident in comments related to time savings for citizens, reduced interruptions, and better ability to service rural citizens in emergencies. Comments related to reduced complaints and better informed political decisions also suggest that these outcomes would lead to a positive perception of integrity in the government. This in turn led to greater trust (e.g., more people less reluctant to pay), as well as increased legitimacy (e.g., through more buy-ins into political decisions). This public value type was most strongly identified in the use case on resilience.

Strategic value in the use cases was attributed to three main aspects. Primarily, it is associated with the use case on urban planning, where it was perceived to stem from improved decision-making ability related to development and planning and was clearly evident (mainly from the urban planning use case). This related to more holistic development, improving the status quo in development decisions, planning for more efficient use of space, and improved ability to prevent major infrastructure failure by having high quality 3D geospatial data (e.g., geological models). There was also an element of improved effectiveness and efficiency in public tasks (e.g., data production efficiency, quicker response times, etc.). Finally, 3D geo-information was perceived to enable improved communication between public sector decision-makers and their stakeholders, as well as to aid comprehension of complex datasets (e.g., traffic impact).

The data was also analyzed to explore how the four public value generating mechanisms were constituted in the use cases. Figure 5 (again using the code frequencies as an approximate quantitative indicator) demonstrates that new or improved processes linked with the use or application of 3D geospatial data that led to an increase in desirable outcomes, i.e., effectiveness, was the main way public value was perceived to be generated. This ranged from improved analytical tools (e.g., in risk assessment, in strategic planning, flood mapping, etc.) and more effective public sector responses, to citizens' needs (e.g., in disaster times, placement of flood mitigation structures, reduced response time, etc.), potential for a lower skilled workforce to do more through automated data processing, and better engagement with stakeholders (e.g., through improved visualization and training). Efficiency did not emerge as a dominant mechanism, but was nonetheless indicated in activities that directly reduced resource consumption, e.g., data processes like image matching, a move to desktop valuation, reduced duplication, and more efficient deployment of public assets (such as in emergencies).

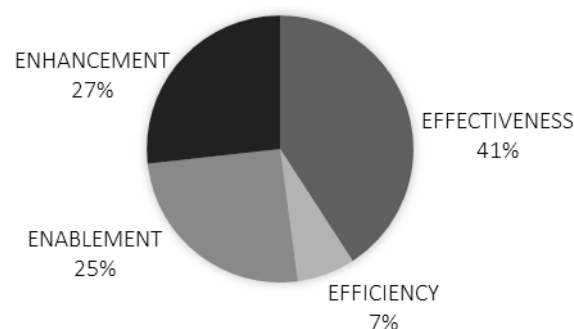


Figure 5. Distribution of public value generation mechanisms across use cases.

The use and application of 3D geo-information was also perceived by stakeholders to lead to new processes. New processes that provided the public or private sector with new or extended abilities were interpreted as resulting in public value creation through enablement. These included processes like plume modelling, identifying and blocking potential terrorist escape routes, developing 3D crisis scenarios or fire plans, and improving or new 3D visualization abilities. New identified processes also reflected fundamental improvements in stakeholders' operating environments, i.e., intrinsic enhancement. Generally, this related to an improved data operating environment (accuracy, sharing, quality of data, type of data), which in turn was perceived to lead to greater stakeholder confidence and advancements, such as using mapping agencies' maps as a base map.

6. Discussion

Against the backdrop of growing interest from public mapping agencies (PMAs) in the curation, use, and provision of 3D geo-information, this paper aimed to complement a recent European ex-ante economic analysis by exploring the public value creation potential of 3D geo-information innovation for PMAs. The premise of this paper was not intended to be comparative; rather, it is exploratory, and aimed at a more explicit identification of the potential of public value creation associated with

3D geo-information innovation. As set out in the literature review, assisting public managers in the articulation of such potential contributions is key to legitimizing change management.

A review of 11 PMAs' organizational mission statements demonstrated their conception of public value creation to be multi-faceted. Service to the 'public' was directly affiliated with the quality of geo-information products, the ease of use, and security of related transactional services, but also manifesting in PMAs' role as an authoritative source of knowledge. Indeed the public expectation that PMAs' tasks seem most concerned with meeting was enabling sound development decision-making for individuals, industry, or other sectors of government. Also evident in the mission statements were indications of both traditional innovation ideals related to effectiveness and efficiency, but also more transformational aspects such as bringing about new capabilities and fundamentally enhancing the geo-information environment. What then are the public value implications of the content analysis? To support managers in PMAs who may be grappling with this change, we frame the discussion below along the dimensions of Moore's strategic triangle.

6.1. *Is There Value?*

The findings suggest that moving towards a model where 3D geo-information is the dominant data environment for PMAs will undoubtedly yield public value. Classification of the feedback from stakeholders demonstrates clear potential in financial and strategic aspects, mainly generated through mechanisms of improving effectiveness of technical products (and subsequently, various workflows and applications), and enhancing the data environment that stakeholders operate in, such as new modes of training and new opportunities for engagement. The potential for public value creation for PMAs could be even more significant, given the fundamental nature of cadastral data for all other development decision-making, and the growing importance of sound urban planning for sustainable development, where PMAs could essentially improve their standing as a 'public asset' [7]. But perhaps therein also lies a challenge for PMAs in public value expositions, in that value tends to be amplified downstream and not easily (directly) linked to their mission statements.

6.2. *Is It Practical?*

Due to the nature of how and why the data was collected, the workshop data was quite limited in its deliberation of whether such innovation might be operationally sustainable. However, specific comments in the data suggest that 3D geo-information innovation is operationally achievable, especially considering that some methods of 3D geo-information acquisition are in fact, now cheaper than acquiring traditional 2D geo-information (or just marginally more expensive for a superior product). Nonetheless, participants also recognized that efficiency gains could potentially result in job losses in the industry. What perhaps might be interesting for PMAs is the emergence of a new network of stakeholders that could be potential collaborators in producing public mapping products and services due to the digital nature of 3D geo-information. This could change the nature of PMAs' operational capacities to one predicated on greater co-production and collaboration with external stakeholders.

6.3. *Will It have Support?*

That the data used in this paper was collected from workshops in multiple countries, and that participants themselves identified almost 30 unique stakeholder types, indicates that a decision by PMAs to invest in 3D geo-information innovation will likely have a broad base in terms of a legitimizing constituency. While the economic analysis undertaken by the PMAs will be integral to seeking and receiving high level political support, this analysis underscores how public value could potentially be experienced in diverse ways by a broad public. However, this diversity also poses a challenge for PMAs to argue for change in terms of effectively consolidating such a diffused support base.

While the concept of public value is notoriously difficult to quantify, given the proliferation of comparative adverbs in the data (e.g., ‘more’, ‘less’), it is evident that the responses from participants—users of and stakeholders in 3D geo-information innovation—demonstrate that exploiting the opportunities presented by 3D geo-information will deliver a positive change in public value creation. However, a public value proposition must be task-specific and focused [16] and while the findings are positive in many aspects, what seems lacking and unclear is whether pursuing innovation in 3D geo-information addresses a specific societal challenge. While stakeholders across use cases are countries that appear to be consistent in the types of public value they ascribe to the use and application of 3D geo-information, the way in which value tends to be generated continues to be more about step-change reform rather than affecting truly transformational change. What this suggests is that there is still no real clear obvious need emerging that can be leveraged to focus innovation policies or efforts but, rather, need is diffused across multiple domains. This lack of direction may impede investment in and adoption of 3D geo-information.

7. Conclusions

The review of the EuroSDR workshop outcomes as presented in this paper, provides another aspect of empirical analysis on the value of 3D geo-information to Europe’s mapping agencies. While the dataset was not originally intended for the purpose it has been used for here, content analysis has provided insight into the broad public’s expectations and needs regarding public sector geo-information products and services. 3D geo-information was seen to enhance governments’ ability to protect citizens’ quality of life by providing advanced analytical abilities that would result in avoiding loss of life and damage to property, improving the safety of emergency responders, and placing and securing vital infrastructure. Associated with such improved outcomes, as well as greater transparency, confidence, and ability to communicate decisions, was an expectation of engendering greater trust in public organizations. Innovation in 3D geo-information would therefore likely consolidate and advance PMAs’ position as authoritative geo-spatial data custodians in several ways and more explicitly emphasize the role PMAs play in fostering secure and sustainable development. This paper is intended to practically contribute to PMAs’ ability to not only identify their innovation position, but to also build a persuasive argument that legitimizes the move to 3D geo-information as a better way to meet the evolving nature and scale of their public mandate.

By adopting a public value perspective, this paper has contributed to a better understanding of the public management aspects of innovation within PMAs, a topic that is seldom tackled. However, the limitations of the data used here suggest that future work should be undertaken, especially research that is explicitly oriented and designed for understanding the public value of 3D geo-information. Specifically, this could start as a study designed around the link between 3D geo-information and public value creation in terms of services, outcomes, and trust, which may also help further solidify the conceptualization of public value that matters for this domain.

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