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Proposing Viable Service Design for Earth Observation Applications: A Research Agenda

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Abstract

With the opening of earth observation data by ESA and NASA under the respective Copernicus and Landsat programs, economic benefits in form of jobs, value creation and widespread societal use of earth observation applications were promised. Yet this promise is still to be delivered, even though there are many examples of earth observation applications. By taking a service design perspective, and applying the service-dominant logic theory, a research agenda for viable service design in the earth observation application domain is created. Four research issues are suggested: using viable service design and business models on services in the earth observation domain, the identification of factors from the applications and data in the domain that influence viable service design, the design of a method guiding service designers to create viable services and ultimately the identification and of cases to which the methods and models are applied.

Keywords: Earth observation application; Viable service design; Service-dominant logic theory; Research agenda;

1. Introduction

The publicly funded ESA Copernicus and NASA Landsat earth observation programs are publishing their data as open data (Wulder & Coops, 2014) in the promise of 30 billion euro of financial benefit for the EU as well as 50.000 new jobs, both by 2023 (ESA, 2015). Yet the promise is, according to a study commissioned by the European Commission, not going to be achieved as even the optimistic scenario only estimates 15 billion euro in economic benefits, of which less than half are generated by end-users (PWC, 2016). A recent and extensive scenario analysis on the earth observation market describes the “value adding EO services” (Denis et al., 2017, p. 429) as emerging and fragmented. The authors state “actual development of the EO services” (p. 431) as one of the key indicators on whether the market for earth observations (which includes satellite manufacturing and launching) will grow. However, how to create services which are not only technologically feasible but also viable has as of yet not been the focus of academic earth observation literature. The viability of a service is achieved when all stakeholders involved in the service creation and delivery have sufficient incentives to provide the service (Sharma & Gutiérrez, 2010). Without achieving viability, the value of a technology remains latent (Chesbrough & Rosenbloom, 2002). The used underlying kernel theory is the service-dominant logic theory, which postulates that all exchanges to the benefit of another actor are services and that services are co-created by multiple actors, including the beneficiary of the service (Vargo & Lusch, 2004, 2016).

The objective of this article is to propose a research agenda for the introduction of viable service design in the earth observation applications domain using the service-dominant logic theory as a foundation. This is done by structurally reviewing earth observation application literature for current viable service design developments. The approach for the review is detailed in the methods section. Then, the results of the review are presented and analysed from a service-dominant logic perspective in order to identify a number of future research topic to create viable services within the academic domain of earth observation applications.

2. Method

To identify articles, a structured literature review is performed based on works of Hart (1998) and Machi and McEvoy (2009). Using the search engine of Scopus and WorldCat, the keyword earth observation is combined with viable service, commercial service, economic value, commercial value and business model. The results of the search are listed in Table 1. A result is considered relevant if the article describes an added value earth observation service, which excludes articles describing any other part of the value chain of earth observation data from launch to data analytics and use. Selected articles are cited in the column to the very right.

Table 1: Searches and results

#	Search	#Results	#Relevant results	Selected articles
1	Earth observation viable services	1	1	(Bach et al., 2010)
2	Earth observation commercial services	16	2	(Denis & Lefevre, 2008; Pelton, Madry, & Camacho-Lara, 2013)
3	Earth observation economic value	12	6	(Bach, Appel, Fellah, & De Fraipont, 2005; Bouma, Kuik, & Dekker, 2011; Bounfour & Lambin, 1999; Häggquist & Söderholm, 2015; Pasher, Smith, Forbes, & Duffe, 2014; Pearlman, Bernknopf, Stewart, & Pearlman, 2014)
4	Earth observation commercial value	1	1	(Beco et al., 2006)
5	Earth observation business model	13	2	(Denis et al., 2017; Sekiguchi, 2009)

3. Review Results

The first search describes the commercialization of a precision farming service, integrating satellite earth observation data with local ground sensors to advice farmers on whether to apply site-specific activities with little operating effort (Bach et al., 2010). This includes parts of viability, where the feasibility of the technology has been demonstrated previously and the service is created to contain usage incentives for the farmer, as well as whether the service provides sufficient value to the farmer for his or her willingness to pay a service provider sufficiently to maintain such a precise farming service. However, the balancing of these incentives is not discussed within the article, not how an operator should maintain the service. In the second search, another article has been identified which describes the use of earth observation applications in the agricultural sector (Denis & Lefevre, 2008). This article describes how earth observations assist farmers, the end users of the service, in not only optimising their processes but also limiting their environmental impact. The reduction in pesticide, water and fertilizer use is not only attractive to the farmers but also to the regional government which has the objective to reduce the environmental impact of its agriculture, creating sufficient incentives for the provision of the service. A different article mentions the inability to create a viable service model for meteorological earth observation data, continuing the data provision as a public good by national governments (Pelton et al., 2013). Although this is not an 'added-value EO service', it does demonstrate that earth observation programs have the clear intention of creating value through services. The rest of the articles from the second search are almost exclusively focused on the earth observation satellites themselves, such as improving their communications and the laws regulating them. And though value-added EO services are a constant theme or final objective, these services are not the focuses of the articles and therefore considered out of scope.

In the third search on economic value and earth observation, the most notable result on value-adding EO services is a feasible service design for the assessment of damages after a flooding by combining land use (i.e. industrial, agricultural, etc.) data with the satellite images flooded areas (Bach et al., 2005). This is a feasible service design as it demonstrates the technical application and names the stakeholders, specifically insurance companies, which are interested but does provide a plan on how to provide the service and on how incentives for continued service delivery are created and maintained. Whilst not directly addressing the added-value EO services, a number of articles within this search describe the idea of earth observation information as a commodity as initially coined by Arrow (1962) to assess the value of the information itself (Bounfour & Lambin, 1999), the value of the information within decision modelling (Pearlman et al., 2014) and the marginal value of information quality improvement (Bouma et al., 2011). The method of assessment for the value of earth observation information is also discussed, noting that methods are often non-comparable or based on ex-ante assessments (Häggquist & Söderholm, 2015), as is for example performed in (Pasher et al., 2014) on the value of earth observation data on wildlife ecosystem monitoring and maintaining. However, these articles concern the resource of earth observation data itself and do not focus on the services which use earth observation data as a resource.

The fourth search for commercial value in earth observation resulted in an ESA study with the architecture for a collaborative environment between EO data users (Beco et al., 2006). The focus is a platform for improved infrastructure for collaboration and knowledge sharing, both for scientists as well as commercial parties providing "commercial value-added products" (p. 1). The focus is again on earth observation data as a resource or product itself, not on the value-adding EO service.

In the last search on business models within the domain of earth observation, no business model for the value added EO services is proposed. Of the two selected, the first article proposes a portal in which earth observation data is offered as data sets with other data sources such as local sensor data already integrated (Sekiguchi, 2009). The second is the earlier EO mentioned market scenario analysis, identifying possible trends and points of attention (Denis et al., 2017). It provides an analysis of the whole service value chain of earth observation data, from instrument development, launch and the value adding service for clients. It also asks where in this chain the profits will be made. This is done by drawing an analogy to the gold rush in the United States, where supplying gold miners turned out to be more profitable than gold mining itself. It specifically states that the promised huge growth in the earth observation and geoformation services will depend, amongst others, on the "actual development of the EO services" (Denis et al., 2017, p. 431).

In conclusion, the objective of creating value with 'value-added EO services' is noted throughout literature, yet these services themselves are currently not fully described within earth observation literature. The applications that go beyond feasibility studies involve different actors and their possible interest in the use of an EO application. Designing the service in such a way that it provides incentives to all stakeholders involved to provide the service and maintain it, i.e. viable services, are not encountered. The focus still remains on the data itself, even when the economic theory concerning the value of information is used. This theory, however, is focusing on resources and is closer to the resource-based view for competitive advantage (Barney, 1991; Barney & Arikan, 2001), not for creating a service that delivers value. The service-dominant logic theory itself is absent from the results.

4. Research issues

Using the perspective of service-dominant logic theory and service design literature, we identify the need for further research within the earth observation application domain, specifically on making earth observation services that fulfil the need of a client and contain sufficient incentives for it uses. We propose the following research issues:

- Application of service design models and business models earth observation applications as to create viable services.

  Within the articles searched, no application of models from service design literature could be identified. These are models such as the business model CANVAS (Osterwalder, 2004), the STOF model (Bouwman, Faber, Fielt, Haaker, & De Reuver, 2008) or the VISOR model (El Sawy & Pereira, 2013). These models allow for the design of viable services, though may need specification towards the application domain, which is included in the following two research issues.

- Identification of characteristics of earth observation applications that make the domain unique in terms of service provision and affect the design of services.
- Identification of earth observation data characteristics that differentiate them in terms of service provision and affect the design of services.

  Earth observation applications and data may have characteristics that differentiate them from other data-based applications and data types. Domain characteristics shape the context in which design choices on business models are made (De Reuver, Bouwman, & De Koning, 2008). Identifying these characteristics allows for the specification of viable service design models towards the application domain. As the domain includes the earth observation data and the earth observation applications, both require investigation.

- Designing a method for the creation of viable services from earth observation applications

Guidance toward achieving a viable service design may not only be beneficial to the advancement of knowledge, this may also have positive influences on non-scientific actors. The market for added-value earth observation data is yet to truly expand (Denis et al., 2017) and a method which guides service designers could facilitate the creation of these services. This lowering the effort of creating services is likely to increase their numbers.

- Identification of cases suitable for earth observation service design.

The only way to be sure the service design models and methods result in a viable service is to apply these models and methods to cases and to evaluate the results. Identifying cases in which are suitable for their application is essential. This would provide academic insights into the functioning of the service design and would actively help companies in realising viable services.

5. Conclusion

Close to all articles reviewed have the ultimate intention to create an application which contributes some form of societal value. Even the ESA and NASA Landsat programs are created with the creation of value in mind. It is likely the publication of the data through these space agencies has led to a great amount of scientific research and applications of earth observations. Now is the time to take the next step and research the viability of the applications researched. Through a structured literature review, the author attempted to capture the current state of viable service design in the earth observation literature. These results are presented and allow for the conclusion that service-dominant logic and viable service design have not yet been applied to the earth observation domain. Based on this conclusion, an agenda for future research is formulated.

Future research should focus on the validation of this research agenda through interviews with experts in both the service design and the earth observation application domains.

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