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Digital forest information platform as service innovation: Finnish Metsaan.fi service use, users and utilisation

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ABSTRACT

Abundance of information characterises decision-making about forest use. This challenges forest owners. Digitalisation and diverse e-services may enhance the delivery of forest resource information and decision support. However, little is known on how e-services engage forest owners. This study explores the Finnish state-funded Metsaan.fi e-service portal as a service innovation. We use web-based survey data about forest owners' views on aforementioned e-service ($N = 5170$) and register data about Finnish forest owners. The identified factors explain the respondents' activity in using the service. Theories of innovation diffusion and e-service quality framed the content analysis of the open-ended questions of the survey. According to the quantitative analysis, owners with timber production objectives and multi-objective owners were the most active users. Forest owners who were compliant with the service's recommendations of silviculture and harvesting operations, used the service actively. This implies that these forest owners had found the service useful. The qualitative analysis shows that independence from time and place and the ease-of-use make the service more inviting. The lack of forest inventory data or its perceived low quality detract forest owners from using it. Many forest owners expect the service to replace forest management plans as decision support tool but the information content there does not fully fulfil those expectations. The study produced knowledge for developing further the online platform and its services. Furthermore, it created understanding about e-government services in the management of natural resources. Specifically, the results argue for noticing attitudinal patterns of intended users when designing governmental e-services. Further research is suggested to integrate innovation adoption theory and service-research theory to dig deeper into the value creation and service needs of different user groups.

1. Introduction

1.1. Study motivation and objectives

Achieving environmental sustainability requires knowledge of complex socio-ecological systems like forests (Dietz et al., 2003). The amount of information on the state of nature is growing and this information is increasingly demanded on different fields of society. Information and communication technology (ICT) is a service enabler that offers opportunities to deliver information services on the internet (Lusch and Nambisan, 2015), both as e-government and commercial e-services. While commercial e-services are pivotal for connecting companies with their customers, publicly funded e-government services provide various benefits for the society. Those benefits include, for example, better access to information and services, cost savings for individual citizens, and fulfilment of democratic principles, such as deliberation and participation in policy developments (Rose et al., 2015).

Metsaan.fi is an internet-based, state-driven forest information and e-government service for private, mostly small-scale forest owners (FOs) and forest service providers. It was launched in 2012 and is managed by the Finnish Forest Centre, the state authority responsible for forestry legislation enforcement, collection and sharing of forest-related data and forest advisory and promotion tasks. Its main purpose is to offer FOs easy access to their forest information and hence help them actively decide about the management of their forests.

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Innovation is a multi-stage process in which organisations transform ideas into new or improved products, services or processes (Baregheh et al., 2009). The purpose of innovation is to create value, which may be expressed as improved economic revenue, employment, growth, sustainability or social welfare (Bessant et al., 2015, p. 12). Service, in turn, consists of activities within one provides benefits or value to another (Vargo and Morgan, 2005). Service innovations are defined as "the introduction of new services to the existing or new clients and offer of existing services to new clients" (Damanpour et al., 2009). For example, with information technology, information, skills and knowledge are combined and exchanged in ways that create value for involved actors (Barrett et al., 2015). Metsaan.fi creates a value network where the platform itself, the FOs and service providing companies create value propositions together (Laakkonen et al., 2019). The rapid development and spreading of ICT has been a fundamental prerequisite for the development of many service innovations (Barrett et al., 2015). Governance tools and practices can further the process of innovation by reducing uncertainties with information provision, strengthening cooperation and problem solving, and providing incentives (Edquist and Johnson, 1997). Metsaan.fi is one example of this kind of innovation governance, as the system offers a digital platform for which private companies can develop their services, products and technologies (Gawer, 2009).

A service platform is a structure that comprises tangible and intangible resources and facilitates the interaction of actors and resources, hence serving as a venue for service innovation (Lusch and Nambisan, 2015). The Metsaan.fi platform for example produces and distributes forest inventory and environmental data that is too expensive for an individual actor to produce and gathers potential clientele together. For forest owners it offers information in an innovative way without charge. It also brings forest owners and service providers together as they can leave and receive offers and bids for forest-related work. To gain its full potential as a meeting point for forest owners and service providers, it must fulfil the information and service needs of as many forest owners as possible, thus enabling the exchange of intangible benefits connected to users' forest ownership and management. This study examines the adoption and use of a forest information platform as a service innovation. Because of the important role of ICT in the delivery of Metsaan.fi as service innovation, analysis links the value creation of an intangible knowledge service and characteristics of e-services.

This study contributes to a general understanding about the users, the utilisation and diffusion of e-government service in the management of natural resources. Theoretically it combines Rogers' theory on diffusion of innovation (e.g. 2003) in forest-related innovation with literature about e-service quality and e-satisfaction. This combination allows a better understanding about adoption of an electronic service as innovation. Earlier research has found certain characteristics that are similar with adopters of technological service innovations (Lee and Lee, 2000). Consumers' perceptions of innovation characteristics are found to influence their willingness to adopt those innovations (Lee et al., 2003). If a new technology used in a service innovation is perceived too difficult to use, consumers adopt a negative attitude towards the service (Laukkanen, 2016). As Metsaan.fi e-service was developed to offer forest owners decision support, it is important to study the ways FOs use it in their forest-related decision making and how the service meets those needs. We study the following research questions in the context of the Finnish Metsaan.fi service platform and its users:

i). Which FO characteristics explain the probability of using the service actively?
ii). What attributes in the service affect (either in encouraging or discouraging manner) whether the forest owner utilises or does not use the service?
iii). How might the service support FOs better in their forest-related decision making?

1.2. Study context: Forestry in Finland and the Metsaan.fi service platform

In Finland 86% of the land area is productive forestland (Natural Resources Institute Finland, 2018), with 53% owned by private FOs, an average holding size being 30.5 ha (Natural Resources Institute Finland, 2019). More FOs are increasingly interested in forest benefits other than timber production, such as recreational and aesthetic forest values (Häyrinen et al., 2015; Leppänen, 2010) and expect their forests to be managed to provide other ecosystem services besides timber (Pynnönen et al., 2018). Because of the great number of FOs and the financial importance of the forest sector for Finland (Rantala and Primmer, 2003), there is a long tradition of the state providing advisory services and forest resource information for FOs, mainly emphasising the timber production (Hokajärvi, 2012).

The Metsaan.fi service platform contains holding-level information about owners' forests. Users identify themselves by using electronic banking passwords when logging in (Finnish Forest Centre, 2016). There are aerial photos, maps of the estate (e.g. terrain map, forest stand compartments map), forest inventory data, and information about nature or cultural-historic values, for example the Natura2000 conservation sites (Valonen et al., 2019). The service also offers recommendations about forest management works and harvests that are calculated automatically based on the inventory data. The inventory data are collected mainly by remote sensing methods. In the platform the FO can make a statutory announcement to the forest administration about forthcoming harvests, apply for subsidies for certain forest management or biodiversity-protection work and search for forest service providers to conduct work in their forest (Finnish Forest Centre, 2016). Metsaan.fi is also open to forest service providers, who can look for potential customers there and utilize the forest data when negotiating with the forest owner, with the agreement of the FO.

The system was initiated to make better use of forest inventory data collected by the Forest Centre and to help FOs to decide about the management of their forests with easily accessible information (Valonen et al., 2019). Before Metsaan.fi this information has mostly been delivered as forest management plans (FMP). The FMP is a voluntary, holding-level plan that contains information and maps about the forest characteristics, recommendations for harvesting and forest management work including information about their costs, the nature values to be considered, and according the owner's wishes, additional information about ways to e.g. enhance biodiversity values in the forest. They are ordered from a forest service provider with a market price.

Development of this service platform has been done with an emphasis on more active timber production, enhancing the profitability of forestry and opening up forest service markets (MAF, 2019). After the present data were collected the service has been further developed, e.g. by incorporating information about sites that are of particular value for game. During the 2010s many service providers have also launched their own commercial e-services for FOs.

2. Theoretical framework

2.1. Innovation attributes and adoption

Innovations diffuse within society in a process in which they are communicated over time among people in a certain social system (Rogers, 2003, p. 35). In this study the social system in which the innovation is diffused and adopted, are Finnish private forest owners. This chapter first introduces the innovation adoption process of an individual, goes then to describe Rogers' (2003) theory on diffusion of innovations with five attributes or perceived properties of an innovation that affect the rate of their adoption (Table 1), and lastly introduces typical categories of innovativeness.

An individual's decision to adopt an innovation is a dynamic process occurring over time and consisting of a series of different actions

Table 1
Distinctive characteristics for e-service quality and e-satisfaction linked to the attributes of diffusion of innovation by Rogers (2003).

E-service quality characteristic	Example	Diffusion of innovation attribute (Rogers, 2003)	Reference to e-service literature
Reliability	Delivering the requested service	Compatibility	Cristobal et al., 2007
Responsiveness	Willingness to help customers	Trialability, relative advantage	Li et al., 2002
Usability, ease-of-use	Ability of a customer to find relevant information and features	Complexity, trialability, relative advantage	Collier and Bienstock, 2006
Security, privacy	Protecting the customer from risk of fraud and protection of personal details	Compatibility, perceived risk (de Ruyter et al., 2001)	Bressolles et al., 2014
Web design, aesthetics	Appearance of the webpage, such as the graphics, and the colours used	Observability, trialability	Bressolles et al., 2014
Information quality	Clarity and precision of the information	Compatibility	Bressolles et al., 2014
E-satisfaction characteristic	**Example**	**Diffusion of innovation attribute (Rogers, 2003)**	**Reference to e-satisfaction literature**
Ease-of-use	Response speed and the logics of navigation	Complexity	Alpar, 1999
Information content	Quantity, quality, accuracy, customer orientation of the content	Compatibility	Alpar, 1999
Entertainment	Amusement and excitement	Compatibility, trialability	Alpar, 1999
Interactivity	Live chats and alike	Trialability, observability	Alpar, 1999

(innovation-decision process) (Greenhalgh et al., 2004). The process starts from *gaining knowledge* about the innovation, where the socio-economic characteristics, personality and the ways the adopter uses communication channels play an important role (Rogers, 2003, p. 170; Scott et al., 2008). Then comes the *persuasion phase*, where the perceived attributes of the innovation itself are of particular importance (Solvak et al., 2019). In the *decision stage* an individual decides whether to adopt or reject the innovation. The *implementation* may take quite long time. Users may postpone deciding about adoption until the innovation develops to replace their current product of service (Szmigin and Foxall, 1998). After implementation the adoption is confirmed, as individuals seek for *reinforcement* for their decision to keep using the innovation, but they may also decide to discontinue use (Rogers, 2003, p. 217). Postponing the adoption of innovation may lead to future adoption but the rejection terminates the innovation decision process (Laukkanen, 2016).

The innovation attributes by Rogers (2003) are relative advantage, compatibility, complexity, trialability and observability (see Table 1). These attributes explain the majority of the variance in the rate of adoption, which is the speed at which an innovation is adopted in a certain social system (Rogers, 2003, p. 221). Some authors add perceived risk as the sixth attribute (de Ruyter et al., 2001). Besides these, the type of innovation-decision, ways to gain information, and the social system where the innovation is being diffused, affect the rate of adoption (Rogers, 2003, p. 221). The perception of the attribute that the decision maker has about the innovation matters, not the objectively classified attributes themselves. We consider the practical service features falling within these attribute categories as factors that either encourage the FO to adopt and actively use the service or discourage the FO to adopt the service or causes even a rejection of it at some point of their innovation decision process.

The first attribute, *relative advantage*, is the "degree to which an innovation is perceived as being better than the idea it supersedes" (Rogers, 2003, p. 229). It can be expressed as economic profitability, social prestige or decrease in discomfort (Scott et al., 2008). It is often linked to characteristics like ease-of-use and time-saving (de Ruyter et al., 2001). Attribute is closely linked to perceived usefulness in technology acceptance model (TAM) (Davis, 1989; Laukkanen, 2016). Perceived relative advantage is the strongest predictor for the rate of adoption (de Ruyter et al., 2001; Pannell et al., 2006).

The second attribute, *compatibility*, is "the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters" (Rogers, 2003, p. 240). A more compatible idea is easier to regard as familiar, or is perceived as fulfilling the adopter's need. Compatibility or incompatibility is linked either to sociocultural values and beliefs (Mascia and Mills, 2018), previously adopted ideas or one's perceived needs for the innovation (Wejnert, 2002). The innovation's compatibility with the adopter's previous knowledge, such as experience in using web-based services, speeds up or slows down the rate of adoption (Rogers, 2003, p. 243; Wejnert, 2002).

The third attribute, *complexity*, is the "degree to which an innovation is perceived as relatively difficult to understand and use" (Rogers, 2003, p. 257). It is aligned with the concept of (perceived) ease-of-use from the TAM (Teo and Pok, 2003). Being perceived as complex may create a considerable barrier to adoption for an innovation.

The fourth attribute, *trialability*, is "the degree to which an innovation may be experimented with on a limited basis" (Rogers, 2003, p. 258). It refers to the concrete easiness of trying the innovation out but also to factors affecting learning from the trial (Pannell et al., 2006). Innovations that are perceived as easily trialable before being fully implemented are more readily adopted (Scott et al., 2008). Different incentives can be used to increase the adoption rate of a certain innovation e.g. by facilitating its trial use (Rogers, 2003, pp. 236–238; Saltiel et al., 1994).

The fifth attribute, *observability,* is "the degree to which the results of an innovation are visible to others" (Rogers, 2003, p. 258). The rate of adoption increases if the positive outcomes from the implementation of the innovation are easily visible or communicable to others (Greenhalgh et al., 2004).

The sixth attribute*, perceived risk,* is "the degree to which innovation performance and psychological (concern regarding others' opinions of one's decision) risks are attributed to the innovation" (de Ruyter et al., 2001). With online services perceived risk may be related to financial, physical or social risks as well (Forsythe and Shi, 2003).

Five categories of innovativeness are typically distinguished: innovators (about 2.5% of the members of a social system), early adopters (13.5%), early majority (34%), late majority (34%) and laggards (16%) (Rogers, 2003, pp. 280–281). Important differences can be distinguished between the typical characteristics of individuals in different categories, although there are no sharp borders between adopter categories (Greenhalgh et al., 2004).

As an example of earlier studies of innovation adoption among forest owners, Rametsteiner and Weiss (2006) found that owners of large properties in Central Europe were often clearly more likely to adopt innovations than smaller landowners. In Finland age and gender have been found to affect the adoption behaviour of internet banking services (Laukkanen, 2016; Mäenpää et al., 2008; Mattila et al., 2003a; Mattila et al., 2001), which have many similarities with the present case of Metsaan.fi e-service. Earlier adopters seek more information, have wider social networks, including change agents, communicate more interpersonally, and seek information about innovations more actively than later adopters (Rogers, 2003, p. 291). Corresponding findings from Finnish forest owners' voluntary protection decisions were reported by

Korhonen et al. (2013), including the important notion of temporary protection as a trialability attribute. Further, earlier adopters generally have longer formal education, higher social status, larger units of adoption and higher income (Rogers, 2003, pp. 288–292), which was found by Khanal et al. (2019) to be the case with US landowners' adoption of carbon sequestration program. Longer education and higher income were found to affect the adoption of internet banking among older users in Finland (Mattila et al., 2003b). However, education did not affect the adoption of internet banking in the USA among younger age classes (Lee et al., 2003).

2.2. E-service quality and e-satisfaction as drivers for e-service use

Electronic services (e-services, in literature also online services or web- or internet-based services) are customer services offered via internet, such as internet banking (Ariff et al., 2013; de Ruyter et al., 2001). They are interactive and content-centred and integrated with the technologies and systems offered by the service provider (de Ruyter et al., 2001). In e-services customers contribute to service delivery by actively using their own effort and time (Bressolles et al., 2014).

E-service quality (e-SQ) refers to the consumer's overall evaluation on the quality of an e-service (Santos, 2003). For e-services like Metsaan.fi service intended for information delivery or promotional purposes, the quality refers to the consumer's judgment on the processes and outcomes of the interaction (Gummerus et al., 2004). A review study by Ladhari (2010) disclosed six key characteristics for e-SQ: reliability, responsiveness, usability, security, web design, and information quality. *E*-satisfaction can be defined as "a cumulative, attitude-like judgment that is based on customers' past experiences" (Gummerus et al., 2004) or as customers' judgment on their experience with a specific service compared to their other service experiences (Anderson and Srinivasan, 2003).

The characteristics of e-services affecting their perceived quality and users' satisfaction with the service describe similar attributes than Rogers' innovation attributes, but in a more concrete way (see Table 1). *E*-SQ has been found to influence e-satisfaction (Wolfinbarger and Gilly, 2003). Different kinds of customers emphasise different aspects of the quality of the e-service concerning their perceived e-satisfaction (Bressolles et al., 2014). Four website characteristics are of particular importance for e-satisfaction: ease-of-use, information content, entertainment and interactivity (Alpar, 1999). The e-SQ and e-satisfaction characteristics are presented in Table 1 with examples, linking the characteristics to innovation attributes by Rogers. The importance of security and privacy are found to be decreasing compared to earlier studies (Bressolles et al., 2014; Wolfinbarger and Gilly, 2003). In services that involve personal, even sensitive information the trust has been found to be equally important than in services that require financial exchanges, where a lack of trust has been the most important reason for not adopting the service (Gummerus et al., 2004). For example, the perceived risk affects the intentions to use internet banking (Martins et al., 2014).

A specific branch of e-services are governmental services, such as tax administration, or as in this study, Metsaan.fi. E-government uses ICT to effectively provide governmental services and information to citizens, businesses and other governmental agencies (Rose et al., 2015). Trusting the administrative body significantly influences the adoption of e-government services (Alzahrani et al., 2017).

3. Materials and methods

Two datasets were used for analyses: large survey data and register data. The analysis of the data was implemented in two parts: with quantitative modelling using survey and register data and with qualitative content analysis of the responses to open-ended questions of the survey. The different analyses and data used for them are presented in Fig. 1. Datasets and methods used are described in more detail in chapters 3.1–3.4. Research question 1 on the forest owner characteristics that explain the use of the Metsaan.fi e-service was responded with quantitative modelling using survey and register data. Research question 2 on the encouraging and discouraging features of the Metsaan.fi e-service was responded with qualitative content analysis of the responses to the open-ended questions of the survey. Research question 3 on improving the service as decision support for forest owners was responded by integrating the findings from the two above analyses.

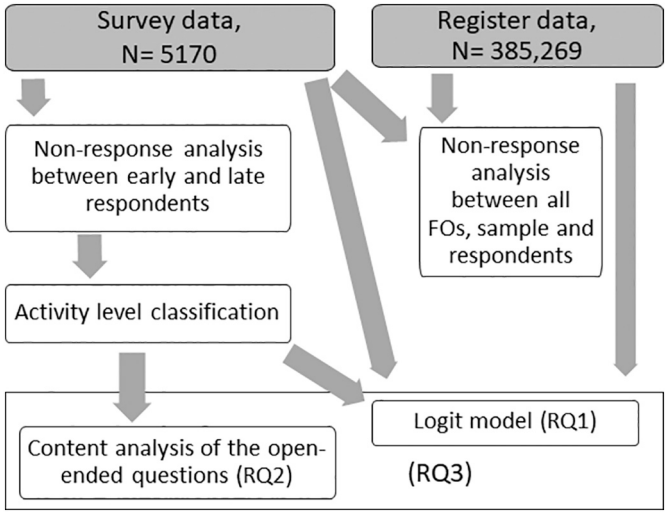

Fig. 1. The analysis process and datasets used. RQ1-3 in the figure refer to research questions.

3.1. Data

Data were collected in an internet survey during August and September 2016. A link to the survey was sent via email to those Finnish FOs who had logged in to the Metsaan.fi service at least once between March 2015 and July 2016 and left their e-mail address and who own at least 2 ha of forest land. The Forest Centre provided the email addresses. A survey was sent to 35,139 recipients and 5742 responses were received, hence the answering rate of the survey was 16.3%. Some respondents ($N = 572$) had not used the service after initial registration, and they were excluded from the data.

The survey consisted of multiple-choice questions, statements to be answered on a five-point Likert-scale, and open-ended questions. The multiple-choice questions dealt with the frequency of the service use and considered the importance or usefulness of service features. Statement questions dealt with user experiences of the service and respondents' objectives for their forest owning. One set of statements presented possible new features to be developed for the service. Demographic background information (age, gender, education level and place of living) and key variables about forest holding (form of possession of the holding, duration of the forest possession) were requested. In the open-ended questions the respondents were asked to describe in their own words what in the service is particularly good, and what would need to be improved.

The register data describing Finnish FOs was produced by the Forest Centre. The register data consist of altogether 385,269 records, representing all Finnish forest owners who own at least 2 ha of forest land alone or together with one other person (e.g. their spouse or sibling). The register data contain demographic variables (gender, age, place of living) and information about the owners' forest holdings (e.g. duration of ownership, number of holdings, aggregated area of forest holdings).

3.2. Description of respondents and evaluation of non-response

The representativeness of the survey data was evaluated by comparing survey respondents with the survey sample, and the survey sample for the Finnish FO's in general. Additionally, the early and late respondents were compared. The significance of the differences was calculated with two-tailed *t*-tests. The background variables and the results of the non-response analysis are presented in Table 2. Information about respondents' education and occupation are based on the survey data, and hence only available for survey respondents.

Age-wise the registered users of Metsaan.fi differ significantly from Finnish FOs in general. Clearly less users over 70 years have registered (11.4% vs. 26.6%). Users over 71 years and from age class 61–70 years have however responded to the survey more often than their share is. The share of 23–40 years old is somewhat larger in the service users than their share of all forest owners; however, they answered the survey clearly less frequently, and are underrepresented in the data. There are clearly less women registered in the service than their share in the register data (19.5% vs. 39.1%) and even fewer women answered the survey (17% of all respondents). Comparison of early and late respondents showed statistically significant differences (all $p < 0.05$) in shares of women and men; within age classes 51–60 and 61–70; within forest area classes 10.1–20 ha and over 200 ha; and within the share of salaried persons (appendix B, Table B1).

Owners of forest holdings larger than 50 ha are clearly overrepresented and owners of the smallest holdings are underrepresented in the survey data compared to forest owners in general. Compared to registered users of the service the distribution in the area classes is, however, quite similar. FOs whose forest holdings lie elsewhere than in the municipality they live answered the survey somewhat more often than their share of registered users or forest owners in general.

The most common education of the survey respondents was a Bachelor's degree or equivalent (36%) and vocational education (31.1%). The majority of respondents (59.8%) have higher education. Compared to the latest wide survey about Finnish forest owners by Hänninen et al. (2011), in our data there are more salaried persons

Table 2
Description of survey respondents', survey samples' and Finnish Forest Owners' background variables.

	Survey respondents, %	Survey sample, %	Two-tailed -test (respondent and sample)	Finnish Forest Owners, %	Two-tailed t-test (sample and Finnish FOs)
Age classes, %					
71–90	17.5	11.4	***	26.6	***
61–70	35.1	28.7	***	26.9	***
51–60	26.1	29.0	***	21.9	***
41–50	14.6	18.1	***	13.9	***
23–40	6.7	12.9	***	10.7	***
N	4064	23,780		356,882	
Gender,%					
Female	17.0	19.5	***	39.1	***
Male	83.0	80.5	***	60.9	***
N	4607	28,387		385,269	
Aggregated area of forest holdings					
2–5 ha	2.9	3.0		22.2	***
5,1–10 ha	5.8	5.4		14.5	***
10,1–20 ha	12.4	11.1	**	16.3	***
20,1–35 ha	16.7	15.2	**	13.9	***
35,1–50 ha	12.4	11.8		8.5	***
50,1–100 ha	23.0	24.1		13.8	***
100,1–200 ha	17.3	18.8	*	7.8	***
over 200 ha	9.5	10.6	*	3.0	***
N	4580	28,244		381,991	
Distant owners					
All forest holdings in the municipality of residence	25.0	27.5	***	27.7	–
All forest holdings elsewhere than municipality of residence	44.8	39.0	***	37.1	***
Both in municipality of residence and elsewhere	30.2	33.5	***	35.2	***
N	4607	28,387		385,269	
Education					
No vocational education	6.9				
Vocational education or equivalent	31.3				
Bachelor's degree or equivalent	36.0				
Master's degree or equivalent	23.6				
Postgraduate degree	0.2				
Other	2.0				
N	4980				
Occupation				**Occupation**[a]	
Salaried person	35.3			30	
Agricultural or forest entrepreneur	12.7			16	
Other independent entrepreneur	7.3			7	
Pensioner	39.6			45	
Student	2.2			2	
Unemployed	2.8				
Other	0.2				
N	5079				

The survey sample consists of all registered users of Metsaan.fi, and the Finnish Forest Owners is the sample of 385,269 FOs from the FC register. Differences between the respondents and the registered users and between all users and FOs in general were tested with two-tailed t-test. Statistically significant values are marked with asterisks ($p < 0.05$ = *; $p < 0.01$ = **; and $p < 0.001$ = ***).

[a] Based on Hänninen et al. (2011).

(35.3% vs. 30%) and less pensioners (39.6% vs. 45%) and agricultural or forest entrepreneurs (12.7% vs.16%).

3.3. Activity level classification

Prior to analysis the data were classified into seven groups based on the respondents' level of activity in using the service. The purpose of the classification was to describe the versatility of the service utilisation as a tool for decision-making.

The level of activity was determined based on six questions that indicate how much and in what ways the respondent had used the service. The activity classes range from 0 (uses the service more seldom than weekly or monthly, and hasn't used the service for gaining information for decision making or licensing different forest uses) to 6 (uses the service weekly or monthly, and takes advantage of the information provided when planning forest management and felling activities, and uses the service functions to apply for licences). The questions or statements used for classification are presented in Table 3. The frequency of each activity class is presented in Table 4. The most respondents belong to activity class 2 (1580 respondents, 30.6%) and 3 (1212 respondents, 23.4%). 10.1% (524 respondents) belong to the narrowest activity class 0, and altogether 3.3% belong to the most versatile activity classes 5 and 6 (160 and 9 respondents respectively).

3.4. Analysis methods

The activity of the use in the Metsaan.fi service was analysed with a binary logit model (e.g. Greene, 2003). The activity level was indicated in a binary format. In the activity variable, forest owners were active if their activity level (see Table 3) was three or above. Forest owners who had two activity indicators or below, were classified as narrow activity users as they use only very few features of the service if any.

The modelling phase was exploratory, i.e. the explanatory variables were chosen from the large set of the variables in the survey data. The set of possible explanatory variables was chosen based on the earlier literature concerning forest owners' activity in forest management as well as on research on the adoption of new internet-based services generally. The variables included forest owner characteristics (age, gender, education, forest ownership objectives), forest area and a stance towards the Metsaan.fi e-service. The forest ownership objective groups were obtained from 5-point Likert scale objective statements. The grouping was carried out with factor analysis and K-means clustering (see Appendix C). We used stepwise procedure in IBM SPSS statistics 25 to select the final models. Both stepwise methods, forward and backward estimation, produced similar final models. This selection of explanatory variables was in accordance with the expectations based on earlier literature and thus they were selected as a final model presented in this article.

The two open-ended questions were analysed separately, and within every activity class. The analysis was conducted in the first phase as an inductive content analysis, drawing analysis categories from the data. The analysis was conducted by a hand in spreadsheet program by the first author and discussed among the authors in different phases. The analysis aimed to describe and quantify which features and characteristics were found good and which not (see e.g. Downe-Wamboldt, 1992) and to search for factors explaining the varying level of activity in the use of the service. The guiding principle was to distinguish service features that the respondents perceived either encouraging adoption or discouraging adoption, potentially contributing to rejection. As the data consist of a great number (about 4900) of individual responses, but single responses consist mainly of only a few words, or lists of separate issues, the analysis concentrated on the manifest content of the data. After analysing one activity class, the analysis categories created were copied to other classes to keep the classes as comparable as possible. However, new categories were added when needed. Once completed, the analysis was checked to make sure it was consistent throughout all activity classes. The categories were then organised under the theory concepts of Rogers' innovation diffusion attributes and e-service and e-satisfaction characteristics. Examining the open-ended questions within this framework ensures that the respondents' own perceptions are transferred straightforwardly.

Table 3
Survey questions or statements used for activity classification.

Survey question	Value	Activity point
How often do you use the Metsaan.fi service?	Weekly / Monthly	1
Have you taken advantage of the electronic forest inventory data when planning forest management work or timber sales?	Yes	1
Based on the forest management and felling recommendations delivered via the platform I plan how and when forestry operations are carried out in my forest	chosen	1
I leave an electric forest use declaration to authorities	chosen	1
I check the ecologically valuable sites of my holding	chosen	1
I have electronically applied for cost sharing for forest management work	chosen	1
	Total	**6**

Table 4
Frequency and share of each activity classes in data. Difference in total percentage is due to rounding of the numbers.

Activity level	Frequency	%
0	524	10.1
1	1031	19.9
2	1580	30.6
3	1212	23.4
4	654	12.6
5	160	3.1
6	9	0.2
TOTAL	**5170**	**99.9**

4. Results

4.1. Results of the logit model

The logit model for explaining the level of activity in the Metsaan.fi e-service is presented in Table 5. Age was expected to have an impact on the adoption of the Metsaan.fi e-service. However, in the logit model for all respondents, age was not a statistically significant explanatory variable for the activity level in Metsaan.fi service. To examine the connection of age and adoption of Metsaan.fi e-service in more detail, we estimated the separate models for all respondents, respondents aged 60 years or less, and respondents over 60 years old. The age group of the forest owner had an impact on how some explanatory variables were associated with the activity in the Metsaan.fi service (Table 5).

All three models were statistically significant according to the likelihood ratio (LR) Chi2 test, thus they performed better than model including only the constant term. The pseudo R^2 was, however, very low. This implies that the explanatory variables in the model did not explain the variation in the dependent variable well at all. The models did, however, provide insight if certain variables were connected to the Metsaan.fi service use or not.

The strong timber harvesting motives of the FO increased the probability of being an active user of Metsaan.fi. If the FOs had multiple objectives for forest ownership, including timber harvesting but also recreation and environmental aspects, they were more active in the use of the Metsaan.fi service. The FOs' activity was higher if they felt that the management recommendations were in accordance with their own forest management goals. This result was similar regardless of the FO's age group.

In a model for FOs aged below 60, agricultural or forest

Table 5
Results of the logit models estimated for all respondents, and respondents aged 60 or less, and above 60 years of age separately.

Variable	All forest owners			60 years or below			Over 60 years		
	Coefficient	Std.err.	*p*-value	Coefficient	Std.err.	p-value	Coefficient	Std.err.	p-value
Constant	−0.849	0.225	0.000	−1.047	0.136	0.000	−1.118	0.132	0.000
Age	−0.004	0.003	0.259	–	–	–	–	–	–
Forest area	0.002	0.000	0.000	0.002	0.001	0.001	0.002	0.001	0.003
Recommendations in accordance with the goals	0.831	0.078	0.000	0.821	0.110	0.000	0.842	0.110	0.000
Female	−0.508	0.115	0.000	−0.556	0.166	0.001	−0.423	0.160	0.008
Goal: Economic and timber production	0.158	0.044	0.000	0.123	0.061	0.045	0.188	0.063	0.003
Goal: Multiobjective	0.264	0.048	0.000	0.306	0.071	0.000	0.229	0.064	0.000
Agricultural or forestry entrepreneur	0.219	0.119	0.066	0.092	0.155	0.554	0.471	0.194	0.015
Distant owner	−0.059	0.082	0.469	0.029	0.119	0.810	−0.158	0.114	0.164
High education	0.216	0.082	0.008	0.171	0.119	0.151	0.268	0.113	0.018
n	3194			1539			1656		
Log likelihood	−2029.270			−983.807			−1043.927		
Pseudo R^2	0.060			0.061			0.060		
LR chi2	258.92		0.000	128.0		0.000	133.32		0.000

entrepreneurship did not have an impact on the activity, but in the older age group it increased it. The forest area had a statistically significant but very low positive impact on the activity in all three models. Thus, the impact of acreage on activity was similar within both age groups.

Women were less active users of the Metsaan.fi service in both age groups. Distant ownership, on the other hand, did not have an impact on the activity. High education increased the probability of Metsaan.fi service use among older FOs.

4.2. Factors affecting the decision to use the service

Responses to question about what is "particularly good" in the service were dealt with as describing factors that encouraged the FO to adopt and actively use the service. Responses to the question what need to be improved in the service were seen as factors discouraging the FO to adopt or even reject the service at some point of their innovation decision process.

The factors encouraging the adoption are presented with illustrative quotes from the responses in Table 6. The quotes are translated from Finnish or Swedish into English. The relative advantage of the service was justified with the possibility of choosing when and where to check the forest issues, to have a web-based alternative in the first place, and the possibility of getting information about one's forests free of charge. The compatibility of the service is linked to the neutrality, credibility and reliability of the service, as well as to the versatility of the information available at the service. Complexity is linked to ease-of-use and technical implementation, and here the responses emphasised the easiness and clarity of the use of the service and its well-functioning technology. Trialability is connected with the gratuitousness of the service, the ease-of-use and technical implementation, which all make it easier to begin to use the service. The observability of the results of the service was linked to existence of it, the up-to-dateness of the information, and the availability of maps and aerial photos and forest inventory data, which are the very core of the service and are now available for every forest owner for the first time.

The discouraging factors, potentially causing rejection are presented in Table 7. The relative advantage is perceived to be lacking at least partly and was linked to problems of linking the service to other operators and services, and to lack of perceived added value from the service. Service providers' low rate of offering their services in response to forest owner's requests for specific work was also criticized. The compatibility of the service with users' expectations, values or needs was considered insufficient. The discordance with one's service-needs was related both to preference for doing business face-to-face with a forest expert and to lack of needed features in the service. Complexity and trialability were both linked to the usability of the service. As a complexity issue the service was found to be too technical and complex to use or could not be modified in the way required. With trialability the problem was unclear

Table 6
Analysis categories and illustrative quotes from the responses describing factors encouraging the adoption of the Metsaan.fi service, arranged according to Rogers' (2003) innovation attributes alongside related attributes from e-service literature.

Theory concepts	Factors encouraging adoption (analysis category)	Excerpts from the responses (number 0–6 refers to the activity class)
Relative advantage, responsiveness, ease-of-use	Independency of time and place, accessibility	Things can be taken care of at home when I have time or there's a need (0)
	Existence	It exists. It's an improvement to the earlier situation when this didn't exist, and for a forest owner a giant leap and eases life (5)
	Gratuitousness	Using the service for free (3)
Compatibility, security, privacy, reliability, information content and quality, entertainment	Neutrality, credibility, reliability	The service is free and is I believe a neutral perception by the authorities about the state of my forests (5)
	Versatility	Versatility and getting a lot of information about my forest holding (1)
Complexity, ease-of-use	Ease-of-use	The ease of use of the service and its good functioning (5)
	Technical implementation	Logging in with electronic banking passwords, no need for a separate account and a password (1)
Trialability, interactivity, entertainment, web design, aesthetics, ease-of-use	Gratuitousness	Free of charge, which lowers the threshold to use the service (1)
	Ease-of-use	It is easy to use the service (2)
	Technical implementation	It works well even though the internet connection in rural areas is not that fast (4)
Observability, web design, aesthetics, interactivity	Existence	The idea itself to have this kind of service (1)
	Up-to-dateness	Real-time changes [updated in the service] about the work one conducts (4)
	Maps and aerial photos	Having the maps in digital form is important nowadays (1)
	Forest inventory data	Information about the structure of my forests and possible areas for harvests (3)

Table 7
Analysis categories and illustrative quotes from the responses describing factors discouraging adoption and potentially resulting in rejection of the Metsaan.fi service, arranged according to Rogers' (2003) innovation attributes alongside related attributes from e-service literature.

Theory concepts	Factors discouraging adoption, potentially resulting in rejection (analysis categories)	Excerpts from the responses (number 0–6 refers to the activity class)
Relative advantage, responsiveness, ease-of-use	Problems of linking the service to other operators and services	It should be easier to integrate the corresponding services from Metsaan.fi and from Forest Management Associations (4)
	No added value perceived from the service	I don't know what would be the added value from the whole system when one has the forest management plan from the Forest Management Association. (1)
Compatibility, security, privacy, reliability, information content and quality, entertainment	(Lacking) features for other forest uses than holding level timber production	Proposals for operations that shift the forest from even-aged management to continuous cover forestry, maintaining the nature and biodiversity values. (4)
	Discordance with forest owner's values or objectives	I haven't been there for a while. I got the impression that my ideas about forest management weren't taken into account (1)
	Reliability, credibility	Get rid of errors and inaccuracies, otherwise the credibility of the service suffers (0)
	Discordance with the service needs	I haven't used the service lately. I appreciate the personal relationship with the service providers (0)
Complexity, ease-of-use	Usability	Too technical and out-of-date – should be improved. After a few times testing the service – too difficult to master. It's better to go to the forest by oneself with a forest expert (1)
Trialability, interactivity, entertainment, web design, aesthetics, ease-of-use	Usability	All functions should be clear and with instructions so that I don't have to experiment in finding the functions (2)
Observability, web design, aesthetics, interactivity	Missing or low quality of one's forest data	The forest inventory data are out of date, so I don't have much interest in looking at them! (1)
	Technical functioning	Quite often some errors occur. This happens particularly when browsing the stand-level information (the map of the stand doesn't open) (5)

or missing instructions. Observability of the results of service gave a negative impression especially with missing or perceived low quality forest data or bugs within the technical functioning of the service.

Mainly the same arguments for and against the service were found in all activity classes. However, some differences were found. In the more narrow activity classes (0 and 1) some respondents commented that they did not find any added value from the service, because it did not offer any additional information compared to their forest management plans or because a commercial forest e-service was superior to this service. This reasoning was not found in more active classes. In all activity classes the respondents asked for new functions related to better acknowledging and managing of nature values. There were, however, differences in the tone of these requirements: the service was pronounced to be in discordance with the owner's values or objectives in the more narrow activity classes, whereas the comments in the more active classes were rather neutral in this respect. In the more active classes, there were further comments about the features and functioning of the maps and forest stand information, which indicates an active way of using the service for decision making. In the more narrow activity classes the responses emphasised more the up-to-dateness of the information, from which we draw the conclusion that in those classes the use of the service is still rather familiarisation with the service, by looking around the different features of the service.

The perception of the forest inventory data as being low quality was found to be central for improvements. This was perceived in various ways. For some respondents, the low quality of the data was a problem which concerned the accuracy of the service, whereas for others it weakened the reliability and credibility of the service. The low quality or missing forest inventory data was also most often mentioned as an individual reason for somebody not using the service. There was also some resistance to change, with the low quality of the inventory data being connected to remote sensing, compared to a traditional forest inventory carried out by legwork. The information about the source of inventory data was commented on to be important.

The sheer existence of the service was perceived as a positive, and in addition to this the continuous development done with the service was praised. Important issues were that the service was considered easily accessible whenever and wherever the user was, the storing of forest information in digital form, and the fact that the service was available on the internet. From this we draw the conclusion that an e-service is perceived as an easier way of taking care of forest issues compared to traditional ways of contacting the forest service providers and finding the relevant data from many places.

To find out possible differences in the specific arguments between the activity classes, the frequencies of each category were calculated as a percentage of the responses in every activity class. No clear trends were found between the argument frequency and activity class when looking at and plotting the data. These calculations are presented in Appendix A (Tables A1 and A2). Despite the absence of clear trends, there were some signs of associations between arguments and activity classes: responses in higher activity classes were generally more detailed about functions for forest management, which indicates familiarity with forestry and different operations. The higher activity in using the service and having good knowledge about one's forests and forest management seems to intertwine.

4.3. The service as a decision support tool

According to the results, many FOs want to use the service as their primary decision support tool for their forests. They wish the service to replace the forest management plans in the future that they previously had as the central information and decision support, and now want to use both as complementary tools. Many users perceive that the accuracy and adaptability of the service is not yet good enough to replace the plans, though on the other hand the service was considered good because it offered at least some information for those FOs who did not have a plan.

The disparate numbering and demarcation of the forest stands in the service and in respondents' own forest management plans were often mentioned as problems. Some respondents perceived this as a problem of bad links between the service and other services they used, other respondents perceived it as a problem with the usability of the service. One cannot easily compare the information and recommendations in the Metsaan.fi with information in the previous forest management plan, and this inconsistency also prohibits using these two services as substitutes or as complementing each other. Many respondents wish for

more illustrative information with pictures and graphs, as well more alternative management recommendations. Functions helping co-operation between owners of neighbouring forest holdings were desired, to increase the profitability of their own harvesting plans or to estimate the landscape level effects of harvesting. The possibility of having the historical inventory data visible for each stand was praised, and some commented that the Metsaan.fi service helps the forest owner to plan future work on the holding. Information and forecasts for timber prices were frequently requested for to support the decision making. One more aspect was that a web-based service makes it easy to show forest information to those family members who have not been interested in going to the forest or are incapable of going there, for example because of the long distances. This was reported to stir interest in getting to know the family's forests better.

5. Discussion

5.1. Users and factors affecting the adoption of the metsaan.Fi service

The starting notion for this study is that the Metsaan.fi e-service may serve as a novel innovation governance tool in Finnish private forestry. It aims to do that by providing an operational platform for forest data sharing, e-government operations, and connecting forest owners and service providers. To learn about the e-service's current performance and to inform its further development, this study explored the users and their opinions of the service features. The first research question inquired about FO characteristics that predict one's active use of the service.

Despite its low explanatory power, the logit model used to examine the linkage between FO characteristics and use of service provides general insights about the users of the service. In our model, age did not explain the level of activity in using the web-based service whereas in earlier research literature about the adoption of technological innovations age has usually explained the uptake of innovation (Lin, 1998). However, in a study about Finns' use of internet banking (Mattila et al., 2003a), which as a service is comparable to Metsaan.fi, age only had a modest impact on the use.

When internet banking was new and scaling up (comparable situation to the current one when online forest services are scaling up), typical users were male, between 35 and 40 years, and had at least college-level education (Mäenpää et al., 2008; Mattila et al., 2001). Typical non-users were females over 50 years with low education. A more recent Finnish study with internet and mobile banking (Laukkanen, 2016) found that age and gender significantly predict adoption and rejection of a service. This is similar to our respondents, where females were clearly underrepresented in the data, and in the model they were also less active users of the Metsaan.fi service, particularly in the over 60 years age group. However, in a study about the adoption of e-governance in Estonia, women adopted the service faster (Solvak et al., 2019). In our results the larger the forest property the higher was the probability of actively using Metsaan.fi. High income has explained the acceptance of internet banking (Mattila et al., 2001), and usually owners of large forest properties also have a high income. This group uses the service more actively, which indicates they have adopted this innovation more often than owners of smaller forest holdings. Rametsteiner and Weiss (2006) found a similar pattern in innovativeness in their study. Having a higher education increased the probability of using the service by respondents over 60. Also Mattila et al. (2003b) found that Finnish users over 65 with a university degree used internet banking much more often than their less educated contemporaries. Education did not have an effect on the level of activity in younger age classes, similarly to the results from Lee et al. (2003) about internet banking in the USA.

Our findings about different user groups and their behaviour seem to reinforce the previous knowledge regarding adoption of technological innovations. However, as the low explanatory power of the model indicates, the attributes of the service seem to be more important in determining the activity of the service use than socio-demographic or forest holding-related factors.

5.2. E-service attributes encouraging or discouraging the adoption

The second research question dealt with the attributes of the service that affect whether the service is adopted or not. In the present results, the relative advantage of the e-services compared to other information sources become clear with the independence of the time and place, and the convenience and efficiency of Metsaan.fi. These are found to be important factors that explain the fast growth of e-services and marketplaces (de Ruyter et al., 2001; Santos, 2003) and of internet banking (Mattila et al., 2003a; Mattila et al., 2001). The users expect the use of e-services to be fast and uncomplicated (Mattila et al., 2003a), and also in our data facing any technical problems was found to decrease the interest in using the service, whereas a well-functioning system was praised.

The compatibility of the service with one's values, expectations and service needs was found important. The present qualitative results show that some respondents find the service being in conflict with their values, needs or objectives for owning forests. For example the tendency of women to value conservation and aesthetics more (Häyrinen et al., 2015) might be one reason for women's lower activity using the service. Furthermore, in our present model, having timber production as an objective increased the probability of active use. The majority of the information content of the Metsaan.fi deals with timber production. The scarcity of functions and information related to the nature values of forests and their management, resulting to lack of compatibility with forest owner values, may cause some user groups to reject the service (Haltia et al., 2017; Häyrinen et al., 2015). Preventing that would require diversifying the information content of the e-service.

The qualitative results show that biggest problem with the service has been the missing forest inventory data or the data being perceived as of low quality. As reliability is one of the key characteristics for e-service quality (Ladhari, 2010), the low quality or lack of forest inventory data for individual users has caused considerable dissatisfaction with the service among our respondents. Respondents in the lowest activity classes often reported the lack of forest inventory data, which understandably causes rejection of the service or halting of their innovation-decision process. Keys to mitigate these behaviours include more careful data-quality management and avoiding overly positive marketing material that could lead to disappointments.

Perceived security risks may limit the adoption of electronic technologies especially those containing financial transactions or personal data (Lee et al., 2003). In our results the security of the service was barely mentioned. This is probably an indicator that online banking passwords are considered a good and secure method of identification, as suggested by Mattila et al. (2001) As Metsaan.fi is an e-government service, this shows high trust in forest administration as a service provider (Alzahrani et al., 2017). However, the inconvenience of using banking passwords has been found a reason not to adopt internet banking (Laukkanen et al., 2008), and it might affect the adoption of Metsaan.fi as well.

Ease-of-use has been the most important predictor of e-satisfaction for a majority of users (Bressolles et al., 2014). Especially elderly may find using information technologies difficult and frustrating (Lee et al., 2003) which may create a barrier to adopting e-services (Mattila et al., 2003a). In our results the clarity and ease of usage positively influenced the active use of the service. Having previous experience with technology-based services makes people more open to new e-services (Lee et al., 2003; Mattila et al., 2003a). Finland has been a forerunner in customer internet banking (Mattila et al., 2003b), and this experience has probably made it easier to start using Metsaan.fi. However, users preferring personal contact with their known forest advisors are likely to reject the service (Mattila et al., 2003a).

60% of the respondents were categorised into narrow-activity classes where they barely use the service, but no specific characteristics either in their background or forest holding or in their perceptions about the service attributes were found that would explain this lack of activity. From this we conclude that these users are still at some point in their innovation-decision process. Late adopters wait until they have proof about the performance of an innovation (Rogers, 2003, p. 294). Our results show that for many in the lowest activity classes, a lack of reliable forest inventory data has been the reason for waiting to proceed with their innovation-decision process. They have not yet made their minds up about adopting or rejecting the service and the interest towards the service naturally grows when more inventory data are available. Laukkanen (2016) concluded that non-users of internet banking have not yet identified the benefits of the service innovation or the service providers have not been able to communicate them well enough. These findings extend the previous knowledge about adoption of e-services with understanding about content-based e-government services.

5.3. Metsaan.fi as a service innovation for decision-making

The third research question dealt with the possibilities of the e-service to serve FOs as decision-support. The results from two present analyses jointly show that FOs expect the e-service to function as decision-support, but currently the e-service rather serves timber production oriented FOs.

The service nowadays offers management recommendations based on even-aged forest management that aims to maximize the profits from timber production. As our results show, it is then perceived as most useful by those whose objectives include timber production but estranges those forest owners who, for example, want to manage their forests with continuous cover forestry. With its rather one-sided forest management recommendations the service faces the risk of alienating some forest owner groups (Haltia et al., 2017). This poses a threat to the policy goals of more active forest management and use (Rantala et al., 2020). Emphasis on promoting timber production and harvests may also cause efficiency losses to society at large by neglecting the provision of other ecosystem services (Pohjanmies et al., 2017). It raises a question, whether this approach of recommending only certain kinds of management is suitable for a governmental service that is supposed to develop an information and decision support tool for pluralistic groups of forest owners, independent of their objectives.

Many respondents want to use the service as a substitute for a forest management plan. For a lay person it might look as if the service contains all the same information than traditional forest management plans, but the information there is automatically calculated and hence does not contain the individual consideration of forest owner's objectives and optimisation of the forest use for those. This inconsistency may cause uncertainty in those forest owners who are not familiar with forestry. The Fig. 2 illustrates the differences between the information content of the service (during the data collection) and the service as it was desired according our respondents. Since many respondents expect the e-service to replace their forest management plans as their primary decision support tool, the bottom of the figure shows the information content of a forest management plan in theory to allow comparison.

Another issue with the service seems to have been the low interest from service providers to market their services and respond to FOs. As the service should be a marketplace for forest owners and service providers to meet, one important function of it is missing. This may originate from the reluctance for new ideas that is typical of the forest sector (Innes, 2009), or possible resistance in attitudes and the behaviour of forest professionals in implementing new working methods (Lidskog and Löfmarck, 2016; Rametsteiner and Weiss, 2006). Companies may also prefer to guide their customers to do business on their own e-services. Ensuring the usefulness of using the service for service providers is an important aspect of securing the best possible gains from the system.

Those individuals who would most need the benefits from an innovation (e.g. the less educated) are in general the last to adopt it, and those who adopt it are least in need of it (Rogers, 2003, p. 295). We assume that FOs with more expertise and probably with other means of forest information use the service more actively, and those who do not have access to, for example, forest management plans are inactive in this service too. Knowledge and understanding about the issue affected by an

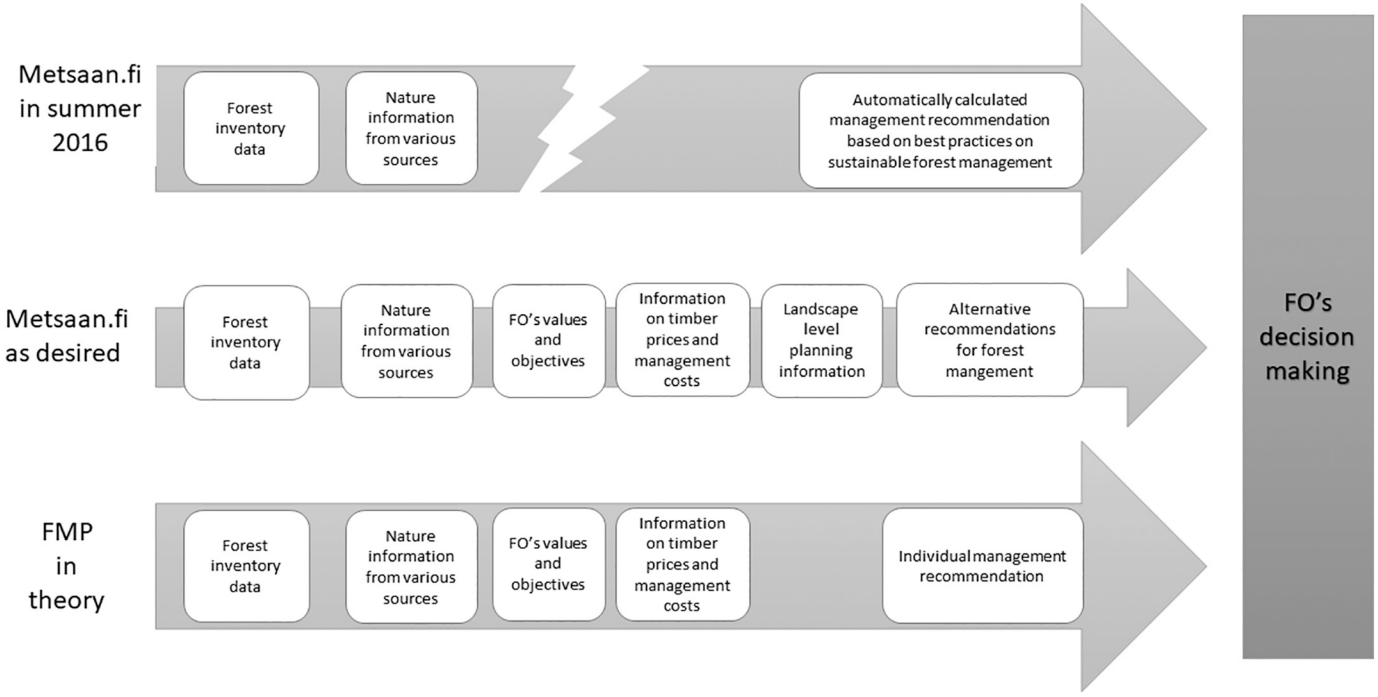

Fig. 2. Illustration of differences between the Metsaan.fi service as it was when present data was collected, as desired according the data, and the forest management plan in theory. Best practices for sustainable forest management are guidance compiled in a multi-stakeholder process led by Tapio advisory and consulting services ((Tapio Consulting Services, 2016).

innovation is a precondition for its adoption and requirement to learn new skills to benefit from it makes adoption less likely (Khanal et al., 2019; Pannell et al., 2006). These new skills may be related both to forest management and using e-services. With further emphasise on e-services FOs who are not capable of using technologies may become further alienated from forest management (Hujala and Tikkanen, 2008).

There are many ways to influence the adoption process, for example through change agents (Rogers, 2003, p. 370) or opinion leaders, or by removing barriers to adoption (Lin, 1998). The advice given by the forest extension experts acting as change agents about how to use the service was noted being important in our results too. Use of peer opinion leaders could help particularly in bringing women to the service who we found being less active users, as the world of IT is still considered a masculine one (Galyani Moghaddam, 2010). These insights help to develop the understanding about e-services as means for information and decision support in natural resource governance.

When looking at the findings of this study through the service-research lens, one may observe that the users generally perceive benefits and create value from neutrality of information and ease of using it. At the same time, their value creation may be distracted because of usability issues, lack of data, and value/feature incompatibilities. These observations call for further analysis that would consider various forest owners' decision processes and how the e-service would enable value-creating encounters between the FO and the data, platform's features and service-providers.

Overall, this research describes one e-service as a decision support and information tool for non-industrial forest owners. The results describe the potential and challenges of an e-government service innovation in the management of natural resources. E-government services enable better access to information and wider participation in decision-making (Rose et al., 2015). However, citizens' access to and skills to use ICT may hinder the realisation of the potential (Carter and Weerakkody, 2008). Understanding the reasons of resistance and overcoming identified obstacles is important for realising the potential of the service (Kuisma et al., 2007). With further development of Metsaan.fi it is important to follow how changes in the service affect the rate of adoption and customer e-satisfaction. More knowledge is needed about different customer segments and their views on the quality dimensions of the service platform. It is important to further study those FOs who have not registered for this service and reasons why somebody chooses to reject it after initial registration. Interview analysis of user groups with different activity levels and modes would be interesting area for further study, as it would provide more nuanced understanding of the operation of the platform. To understand better its innovative potential, research is needed about the views of service providers in the platform, including analysing the different innovative activities in the platform, for example possible forest owner-initiated peer learning. An interesting question would be, whether forest owners have different expectations to state-driven and commercial e-services.

6. Conclusions

This study examines how both the characteristics of forest owners alike the attributes of the governmental e-service explain whether a FO uses the e-service. Furthermore, we identify how the service could better support forest owners in their forest related decision making. Our results show that the features of the service strongly affect FOs decision to use an e-service, rather than the forest owner characteristics or characteristics of their holdings. The distinct discrepancy between the information in the service and the way FOs want to use it for decision-making as a substitute for their forest management plans must be solved so that the service in future genuinely offers relevant information for multi-objective and sustainable forest uses for all forest owners, independent of their objectives.

We found out that the e-service serves better those forest owners who aim for even-aged timber production than those having other objectives and information needs. To gain its potential, it is important that customers with various objectives can implement the service in their forest management regimes and hence become active users of it. Adoption rates may be increased also via paying more attention to service-theory driven features, i.e. learning about FOs' exchange of benefits and value creation with e-services among the different adopter categories. The present study found importance in neutrality and convenience of use, but more research with deeper qualitative insights is needed. A combination of innovation and service research theories, following the example of the present study, may be a fruitful way forward.

Sustainable use of forests is a complex socio-economic system, and managing it requires diverse knowledge, uninterrupted flows of information and more open access to this information. Metsaan.fi as e-government service has great potential in advancing a more sustainable use of natural resources in an effective way. Hence its development in a way that enhances the sustainability of forest use and its legitimacy in society is very important.

Declaration of Competing Interest

The authors declare no conflict of interest. Funding sources have not been involved in preparation of this study.

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Appendix A

Table A1
Frequency of different analysis categories in activity classes for factors encouraging adoption ("What is particularly good in the service?").

Analysis category	Activity class, % of responses						
	0	1	2	3	4	5	6
Maps and aerial photographs	17.4	9.3	12.3	14.3	16.2	7.5	–
Forest inventory data	7.8	8.7	10.6	12.0	11.0	11.2	–
Display of forest resource information	1.8	1.0	7.2	8.2	7.8	2.80	14.3
Recommendations for management and harvesting	5.0	6.4	9.9	13.3	13.2	11.2	–
Gratuitousness	4.6	3.3	4.9	4.4	8.1	10.3	–
Independence of time and place	8.3	7.2	6.4	7.6	7.1	12.1	–

(continued on next page)

Table A1 (*continued*)

Analysis category	Activity class, % of responses						
	0	1	2	3	4	5	6
Up-to-dateness	2.8	1.9	4.4	4.7	9.1	8.4	–
Ease-of-use, clarity	13.3	14.0	11.1	14.4	15.9	18.7	28.6
Independence of e.g. timber buying companies	1.8	1.9	1.0	1.5	3.4	3.7	–
Existence	7.3	8.7	4.0	2.6	3.4	3.7	–
Technical implementation	2.3	3.9	4.0	4.8	2.9	3.7	–
Links to service providers	3.2	2.5	3.1	2.5	2.7	0.9	–
Versatility of the features and available information	3.2	5.0	6.7	5.3	4.9	6.5	–
Seeing all estates at a glance, big picture	4.1	8.0	5.9	6.2	7.1	6.5	–
Possibility for digital forest information, e-service possibilities, helps with planning	5.5	8.2	12.4	11.9	9.3	14.0	28.6
Information for my forest estate is missing	2.8	2.3	0.7	0.1	–	–	14.3
Comments that the service is not good	2.8	1.2	1.8	0.3	0.98	–	–
I don't know	6.9	3.1	3.0	1.8	–	–	–
Total N	**218**	**515**	**877**	**722**	**408**	**107**	**7**

Table A2
Frequency of different analysis categories in activity classes for factors discouraging adoption (What should be improved in the service?)

Analysis category	Activity classes, % of responses						
	0	1	2	3	4	5	6
Maps and aerial photographs	0.6	2.4	2.4	2.7	2.3	2.6	–
Accuracy of forest inventory data	22.7	20.1	18.9	17.5	20.8	17.1	–
Display of forest resource information	4.0	3.4	3.1	4.3	6.0	10.5	60.0
Recommendations for management and harvesting	3.4	0.8	4.1	4.3	4.0	–	20.0
Functions for the forest compartments and maps	1.1	1.6	6.5	7.8	9.1	10.5	–
Usability	6.8	10.0	9.4	11.8	14.8	19.7	–
Up-to-dateness	13.6	14.8	7.8	10.9	2.0	–	–
Need for new features/functions	4.5	6.9	12.2	11.1	9.4	17.1	20.0
Linking the service to other services and operators	9.1	6.9	6.0	5.8	7.0	3.9	–
Credibility and reliability	6.3	3.7	2.8	2.5	13.8	–	–
Other kinds of services needed than e-service			2.3	2.7	1.7	–	–
Examining several forest estates all at once	1.7	0.3	–	–	–	–	–
Information for my holding is missing or of low quality	14.2	5.5	3.4	2.5	2.3	–	–
Total N	**176**	**379**	**615**	**485**	**298**	**76**	**5**

Appendix B

Table B1
Non-response analysis with early and late respondents of the survey.

	Early respondents	Late respondents	Two-tailed t-test
Age classes, %			
71–90	3.0	3.5	
61–70	26.4	23.4	*
51–60	31.2	34.1	*
41–50	23.9	24.8	
23–40	15.5	14.1	
N	2238	1839	
Gender.%			
Female	15.7	17.9	*
Male	84.3	82.1	*
N	2517	1989	
Aggregated area of forest holdings			
2–5 ha	3.9	3.8	
5.1–10 ha	5.8	6.9	
10.1–20 ha	12.6	15.0	*
20.1–35 ha	18.7	17.4	
35.1–50 ha	12.2	12.1	
50.1–100 ha	21.7	22.5	
100.1–200 ha	16.0	15.0	
over 200 ha	9.1	7.2	*
N	2100	1715	
Distant owners			
All forest holdings in the municipality of residence	23.1	25.3	
All forest holdings elsewhere than municipality of residence	29.1	28.3	
Both in municipality of residence and elsewhere	47.8	46.4	
N	2237	1839	
Education			
No vocational education	6.9	7.3	
Vocational education or equivalent	30.3	31.4	
Bachelor's degree or equivalent	36.9	35.8	
Master's degree or equivalent	23.8	23.3	

(*continued on next page*)

Table B1 (*continued*)

	Early respondents	Late respondents	Two-tailed t-test
Postgraduate degree	0.2	0.2	
Other	2.0	1.9	
N	2540	2007	
Occupation			
Salaried person	33.9	36.7	*
Agricultural or forest entrepreneur	12.8	11.9	
Other independent entrepreneur	7.2	6.7	
Pensioner	40.9	39.2	
Student	2.3	2.5	
Unemployed	2.9	2.9	
Other	0.0	0.0	
N	2586	2050	

Non-response analysis were calculated only for Finnish version of the survey, because the Swedish survey was conducted two weeks after the Finnish version. Respondents from the pilot-survey were also excluded. Statistically significant values are marked with asterisks ($p < 0.05$ = *; $p < 0.01$ = **; and $p < 0.001$ = ***).

Appendix C

Table C1
Objectives of forest ownership. Maximum Likelihood analysis, Varimax rotation (loadings below 0.3 are suppressed).

Variable	Factor 1	Factor 2	Communality
	Environment and recreation	Economy and timber production	
Securing the forest biodiversity	0.763		0.582
Securing the scenic views	0.743		0.560
Recreational use	0.615		0.385
Carbon sequestration and securing availability of clean water	0.607		0.380
Forest berries. mushrooms and other products	0.593		0.353
Maximizing economic profit		0.826	0.685
Production of sawlogs. fiber and energy wood		0.710	0.504
Forest holding is an investment or a source of economic security		0.580	0.337
Factor Eigenvalue	2.222	1.562	
Explained Variance %	58.7	41.3	
Cronbach's alpha	0.797	0.736	

Table C2
Final cluster centers for the objective groups. K-means clustering.

Factor	Clusters		
	Environment and recreation	Multiobjective	Economy and timber production
Environment and recreation	−0.794	**0.714**	**0.208**
Economy and timber production	**0.279**	**0.487**	−1.225
Proportion of forest owners, %	39.4	36.9	23.7

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