On the Use of Smartphones, Tablets and Drones in German Forestry

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***Abstract* – Although the use of digital tools such as smartphones, tablets, and drones is expected to have many benefits for forestry, no study has yet evaluated the use of such tools. Hence, this study investigates the use of smartphones, tablets and drones in German forestry. For this purpose, 215 German foresters were surveyed from December 2021 to February 2022. Descriptive data on the use of smartphones, tablets and drones was collected. Furthermore, an extended Technology Acceptance Model (TAM) was estimated to analyze factors influencing foresters' intention to use drones. Despite the proclaimed benefits of digital technologies, not all foresters use a smartphone and/or tablet. Likewise, only a small percentage of foresters use a drone. The TAM explains 44 % of the variation in the intention to use a drone of which perceived usefulness for forest management purposes is the strongest predictor. The results are of interest for policy makers, extension services as well as foresters.**

INTRODUCTION

Although the use of digital tools such as smartphones and drones is expected to have many benefits for forestry (Tomastik et al., 2017, Tang and Shao, 2015), no study has yet investigated the use of such tools. Hence, the aim of the study is to capture the current state of digitization in forestry. The study explicitly focuses on the use of smartphones, tablets and related apps as well as the use of drones. Furthermore, factors influencing the decision to use drones will be investigated within the framework of an extended Technology Acceptance Model (TAM) as proposed by Davis (1989). To the best of the authors' knowledge, this is the first study to address the digitization of forestry from a user perspective with regard to smartphones, tablets and drones.

THEORETICAL FRAMEWORK

To investigate factors influencing foresters' intentions to adopt drones, the TAM proposed by Davis (1989) was applied and extended. The TAM postulates that an individual's intention to use a technology (*INT*) is determined by the perceived ease of use (*PEOU*) and perceived usefulness (*PU*). Furthermore, the *INT* influences the actual adoption. *PEOU* refers to the degree an individual perceives using a technology as effortless. *PU* is defined as the degree to which an individual perceives that a technology is useful for his or her job performance. Both latent constructs (*PEOU* and *PU*) affect an individuals' *INT*. Furthermore, *PEOU* also affects *PU* since the easier a technology is to use, *ceteris paribus*, the higher the *PU would be* (Davis, 1989). The model was extended by adding the latent construct of perceived ecological benefits (*PEB*) and adapting the *PU* to the construct perceived usefulness for forest management purposes (*PUFM*), as drones can be used to monitor the health status of the forest stand and accordingly make better management decisions. The derived hypotheses are displayed in Figure 1.

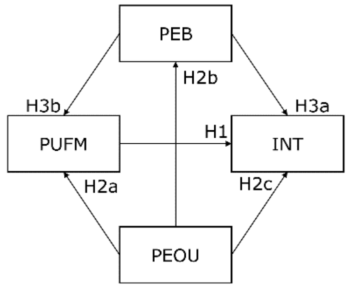

Figure 6. Proposed TAM for the intention to adopt drones in German forestry. H = Hypothesis, PEOU = Perceived Ease of Use, INT = Intention to Use a Technology, PEB = Perceived Ecological Benefit, PUFM = Perceived Usefulness for Forest Management Purposes.

MATERIAL AND METHODS

An online survey dedicated to German foresters was conducted between December 2021 and February 2022. Foresters were invited to participate by e-mail notifications from professional forestry associations in Germany. The survey was divided into three parts. In the first part, the foresters were asked to provide socio-demographic and forest business-related information. In the second part, foresters were asked if they use a smartphone and/or tablet. Foresters who use a smartphone and/or tablet were asked if they use apps for forestry purposes and, if yes, which types of apps they use. Likewise, foresters were asked if they use a drone and, if yes, for which purpose. In the third part, foresters were asked to evaluate statements to estimate the proposed TAM (Figure 1) on a 5-point Likert scale (1 = strong disagreement; 5 = strong agreement). Before that, foresters who had not heard of the use of drones in forestry received an explanatory text. The TAM is estimated using partial least squares structural equation modelling (PLS-SEM) (Hair et al., 2021).

RESULTS, DISCUSSION AND CONCLUSIONS

Descriptive Results

244 fully completed questionnaires were collected, of which 29 were deleted due to unclear answers, resulting in 215 usable records. The average forester in the sample is 48 years old and 47% hold a technical or university degree. 13% of the participants are female. Based on a 11-point scale (0 = risk averse,

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10 = risk seeking) (Dohmen et al., 2011), the average forester in the sample is slightly risk-averse (mean = 4.89). Also based on a 11-point scale (0 = not innovative; 10 = highly innovative), the average foresters can be described as innovative (mean = 7.07). The average forest area in the sample is 10,594 ha. 39% of the participants are also the owners, whereas the rest have indicated that they are employed. 69% of the foresters own a smartphone, of which 62% also use apps related to forestry. A tablet is owned by 43% of the foresters, of which 72% use apps related to forestry. 84% had heard of the use of drones in forestry prior to the survey. A drone is currently used by 10% of the foresters in the sample. Furthermore 6% of the participants indicated that they had already used a drone for forestry purposes in the past. Drone users primarily use drones to inspect tree stands (62%), document storm damage (62%), and determine infestations of pests (43%). They see the advantages of drone use primarily as faster and more accurate data collection (62%) and the ability to respond in a timely manner to calamities such as storm damage (66%). For non-users, arguments against the use of drones include price (48%), lack of technical knowledge in the forestry operation (43%), and lack of technical infrastructure in the forestry operation (52%).

Estimation results

Models estimated using PLS-SEM are evaluated in two steps. In the first step, indicator loadings (λ), internal consistency via composite reliability (CR), convergent validity via average variance extracted (AVE) and discriminant validity via Heterotrait-Monotrait (HTMT) ratios are assessed. Values for λ and CR should be above 0.7. The value for AVE should exceed 0.5, while HTMT ratios should not exceed 0.9 (Hair et al., 2021). The lowest values for λ and CR in the model are 0.746 and 0.885, respectively. 0.620 is the lowest value estimated for AVE. The highest HTMT ratio amounts to 0.723. To conclude, all quality criteria of the first step are met.

In the second step, the relationship between the constructs as displayed in Figure 1 is evaluated by estimating path coefficients (β) and t-statistics using a bootstrapping procedure with 10,000 subsamples. Furthermore, explained variance (R^2) is estimated. Table 1 shows the estimation results for the TAM via PLS-SEM. The model explains 44% of the variation in foresters' intention to adopt a drone. Hence, the results indicate that the proposed TAM is able to capture a large amount of latent information in the adoption process.

As Table 1 indicates, all hypotheses in the model are supported except H3a (PEB → INT). The results show that both the perception that drones or the data collected by drones are useful for forest management decisions and the PEOU have a statistically significant effect on the INT to use a drone. Furthermore, PEOU has a statistically significant impact on PUFM and PEB. In order to promote the use of drones in forestry, extension services and providers of drones should focus on effective communication of the benefits in terms of decision support for management decisions. Likewise, handling of drones and data collected by the drones for forest purposes should be kept as simple as possible for ease of use.

Table 1. Estimation results of the TAM (N=215) [a]

Path	H	β	t [b]	p-value
PUFM → INT	H1	0.451	6.598	<0.001
PEOU → PUFM	H2a	0.478	9.454	<0.001
PEOU → PEB	H2b	0.244	3.644	<0.001
PEOU → INT	H2c	0.281	4.698	<0.001
PEB → INT	H3a	0.025	0.399	0.690
PEB → PUFM	H3b	0.348	6.598	<0.001

[a] H = Hypothesis, PEOU = Perceived Ease of Use, INT = Intention to Use a Technology, PEB = Perceived Ecological Benefit, PUFM = Perceived Usefulness for Forest Management Purposes

[b] Bootstrapping results with 10,000 subsamples.

R^2(INT) = 0.439; R^2(PEB) = 0.059; R^2(PUFM) = 0.431

The current study is focused on the intention to adopt drones. For future research, it could be of interest to investigate foresters' willingness to pay for drone services. Furthermore, this study is based on the TAM by Davis (1989). To further investigate the adoption decision, more sophisticated social-psychological theories should be applied.

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