The Acceptance and Use of Open Data infrastructures - Drawing upon UTAUT and ECT

Zuiderwijk-van Eijk, Anneke

DOI
10.3233/978-1-61499-670-5-91

Publication date
2016

Document Version
Final published version

Published in
Electronic Government and Electronic Participation

Citation (APA)
Zuiderwijk-van Eijk, A. (2016). The Acceptance and Use of Open Data infrastructures - Drawing upon UTAUT and ECT. In H. J. Scholl, O. Glassey, M. Janssen, B. Klievink, I. Lindgen, P. Parycek, E. Tambouris, M. Wimmer, T. Janowski, & D. Sá Soares (Eds.), *Electronic Government and Electronic Participation: Joint Proceedings of Ongoing Research, PhD Papers, Posters and Workshops of IFIP EGOV and ePart 2016* (pp. 91-98). (Innovation and the Public Sector; Vol. 23). https://doi.org/10.3233/978-1-61499-670-5-91

Electronic Government and Electronic Participation
H.J. Scholl et al. (Eds.)

doi:10.3233/978-1-61499-670-5-91

The Acceptance and Use of Open Data Infrastructures - Drawing upon UTAUT and ECT

Anneke ZUIDERWIJK[a,1] and Martijn CLIGGE[a]
[a] *Delft University of Technology, Faculty of Technology, Policy and Management, Jaffalaan 5, 2628 BX Delft, The Netherlands, {A.M.G.Zuiderwijk-vaneijk; M.E.Cligge}@tudelft.nl*

Abstract. While governments and researchers often focus on the opening of data through open data infrastructures, the *adoption* and *use* of open data infrastructures has received less attention, despite the fact that this use should result in the envisioned benefits. This study aims to examine to which extent and by which factors the acceptance and use of open data infrastructures by researchers can be influenced. For this purpose we use an integrated model of the Unified Theory of Acceptance and Use of Technology (UTAUT) and the two-stage Expectation Confirmation Theory of Information Systems continuance (ECT). Our research confirms the hypothesis that Perceived Usefulness (PU), Effort Expectancy (EE), Social Influence (SI) and Trust (T) in the pre-usage stage can be used to predict PU, EE, SI and T in the post-usage stage, which may subsequently influence the acceptance and use of open data infrastructures. Nevertheless, not all of our findings show support for applying the combined UTAUT-ECT model, and the findings suggest that the model needs to be specified and adapted for the domain of open data. We recommend future research to develop models for the acceptance and use of technologies that are more specific to the context of open data.[2]

Keywords. Open data, adoption, use, infrastructure, UTAUT, ECT.

Introduction

Governments often focus on the opening of data through open data infrastructures, and the *adoption* and *use* of open data infrastructures has received less attention in practice. While the scientific literature in the area of open data also often used to focus on the supply-side of open data [e.g., 1], recently awareness started growing that more attention should be paid to the use of open data [e.g., 2, 3]. Paying attention to the acceptance and use of open data infrastructures is important, since this results in more value creation than only opening data [4]. The envisioned benefits of open data infrastructures cannot be realized if open data is not accepted and used.

[1] Corresponding Author.

2 This paper is related to the H2020 VRE4EIC project (www.vre4eic.eu). The authors would like to thank their colleagues of this project for their input for this paper, although the views expressed are the views of the authors and not necessarily of the project.

Although several articles already discuss variables that may influence the acceptance and use of open data [e.g., 5, 6], there are limited studies that provide overviews of such factors from a user perspective. Moreover, most of these studies are not focused on open data infrastructures in particular, while open data is often offered through these infrastructures. In addition, many articles that discuss variables influencing the acceptance and use of open data do not build on existing theories and theoretical models, while various theories about the acceptance and use of technology in general have been developed that might also be relevant in the context of open data infrastructures. The study aims to examine to which extent and by which factors the acceptance and use of open data infrastructures by researchers can be influenced. We focus specifically on researchers as open data users and other types of open data users (e.g. developers and citizens) are outside the scope of this study.

1. Research background

There is no common understanding of the concept 'open data infrastructures'. Related domains, such as the literature on digital infrastructures and information infrastructures, may be used to develop a definition of open data infrastructures. As described in the literature, digital and information infrastructures are often defined as shared systems [7, 8], that can be public or quasi-public [9], and that evolve over time [9]. Moreover, these types of infrastructures contain interacting and connected social and technical elements [9-11] that together form a system. Based on the digital and information infrastructure literature, [12, p. 45] defines an Open Government Data (OGD) Infrastructure as "a shared, (quasi-)public, evolving system, consisting of a collection of interconnected social elements (e.g. user operations) and technical elements (e.g. open data analysis tools and technologies, open data services) which jointly allow for OGD use". We adopt this definition in our study on the acceptance and use of open data infrastructures.

Venkatesh et al. [13] have developed a model that integrates UTAUT and ECT. This model enables us to understand the acceptance and use of a certain technology during the course of its usage. It includes both pre-usage variables, usage variables, and variables concerning the intention to continue using the technology, such as perceived usefulness, trust and satisfaction. UTAUT allows for examining complex and sophisticated organizational technologies of managerial concern [13]. UTAUT has also been used in research on factors influencing the intention to use open government [14], and open data is often seen as an important aspect of an open government. ECT allows for investigating the continuance of Information Systems (IS) [15] as well as changes in the beliefs and attitudes of users during their IS usage [16]. The model of [13] is appropriate for investigating the acceptance and use of open data infrastructures by researchers, since such infrastructures can be considered a specific IS technology in which acceptance and use, but also continuance of use in the future, play an important role. Furthermore, the expanded two-stage model of IS continuance looks at the acceptance and use from a broader perspective than other models do, such as the Technology Acceptance Model (TAM) [17, 18], or UTAUT [13] or ECT [19] by itself.

The key variables in the integrated ECT/UTAUT model of [13] are Perceived Usefullness (PU), Effort Expectancy (EE), Social Influence (SI), Facilitating Conditions (FC) and Trust (T). Following this model, we formulated four hypotheses (see Table 1).

Table 1. Formulated hypotheses.

Hypotheses
H1: Positive disconfirmation of factor X (PU/EE/SI/T) has a positive influence on satisfaction.
H2: Positive disconfirmation of factor X (PU/EE/SI/T) has a positive influence on post-usage factor X.
H3: Post-usage influence of factor X (PU/EE/SI/T) has a positive influence on post-usage attitude.
H4: Post-usage influence of factor X (PU/EE/SI/T) has a positive influence on continuance intention.

These hypotheses include variables from both the pre-usage and post-usage stage, although for reasons of feasibility we do not include hypotheses concerning the influence of each of the pre-usage stage variables on each of the post-usage stage variables. Even though the post-usage factors (PU/EE/SI/FC/T), post-usage attitude, post-usage satisfaction and continuance intention do not directly measure the acceptance and use of open data infrastructures, we argue that these factors can be seen as important indicators. For instance, if researchers do not continue their use of open data infrastructures, this indicates that they do not accept and use the open data infrastructure in the long run. We therefore argue that the post-usage factors, attitude, satisfaction and continuance intention are important preconditions for the acceptance and use of open data infrastructures by researchers.

2. Research approach

In total, 145 people completed two surveys that incorporated the expanded two-stage model of IS continuance by Venkatesh et al. [13]. A first survey was completed in the pre-usage stage, while a second survey was completed in the post-usage stage. The pre-usage survey consisted of questions related to pre-usage attitude and pre-usage beliefs, and the post-usage survey included questions related to disconfirmation (i.e. whether the expectations of respondents were confirmed), post-usage attitude, satisfaction, post-usage beliefs and continuance intention. The beliefs and the disconfirmation encompassed the PU, EE, SI, FC and T. All questions corresponded to the previously validated scales for the constructs as proposed by [13]. The questions were modified to make them suit the context of open data infrastructures [see 15 for the survey].

In the usage stage, the participants completed scenarios related to the use of the open data infrastructures for research purposes using one of two specific open data infrastructures, including searching for data, data analysis, data visualization, interaction about open data and data quality analysis [see 12 for more information about the scenarios]. Approximately 73 per cent of the respondents worked with the ENGAGE open data infrastructure, while 27 percent worked with the DANS infrastructure. Participants were randomly assigned to one of those two infrastructures, but since the number of people that could work with the second infrastructure at the same time was limited, less participants worked with this infrastructure.

Ideally, we would use Structural Equation Modelling (SEM) to investigate the variables influencing the acceptance and use of open data infrastructures. However, since our sample consisted of only 145 responses the data did not meet the assumptions of SEM. Therefore, we used Partial Least Squares (PLS) [20] to analyse the data. PLS can be used for smaller groups of respondents. It can be used to create predictive models for datasets that contain many and highly collinear factors [21]. Since we attempt to find out whether our data can predict the acceptance and use of open data infrastructures, and whether it can predict the intention of a person to continue using

the particular open data infrastructure, we search for a predictive model for using open data infrastructures. Using SmartPLS, we built a model, and thereafter we examined various factors that show the quality of the model. Subsequently, a bootstrapping test was carried out to test the significance of the paths in the model. In case that the t-value of a path was higher than 1.96, SmartPLS removed the path from the model and ran it again. This process was repeated until only the significant paths were left in the model.

3. Factors influencing the acceptance and use of open data infrastructures by researchers

Most of the 145 participants (80%) were between 20 and 29 years old, and most were students (79%). Out of the 142 participants who provided gender information, most were male (75%). The participants were asked to assess their experience with open data use, and this question was answered by 112 participants. On a scale from one (no experience) to ten (very much experience), the majority of the participants (21%) stated that their experience with open data use was on level seven. For almost 60 per cent of the participants their experience was between level three and level six.

Figure 1 shows the results from testing our hypotheses through PLS. We conducted a bootstrapping test to examine the significance of the paths in our model. Non-significant paths are indicated with '-'. There are no significant paths between pre-usage beliefs and disconfirmation and between pre-usage beliefs and satisfaction. The disconfirmation theory described in the UTAUT is not reflected in the results. Interestingly, while there are no significant paths between pre-usage beliefs and disconfirmation, there are significant paths between disconfirmation and post-usage beliefs. The only factor that has a significant influence on continuance intention is perceived usefulness, while post-usage attitude shows a strong significant result.

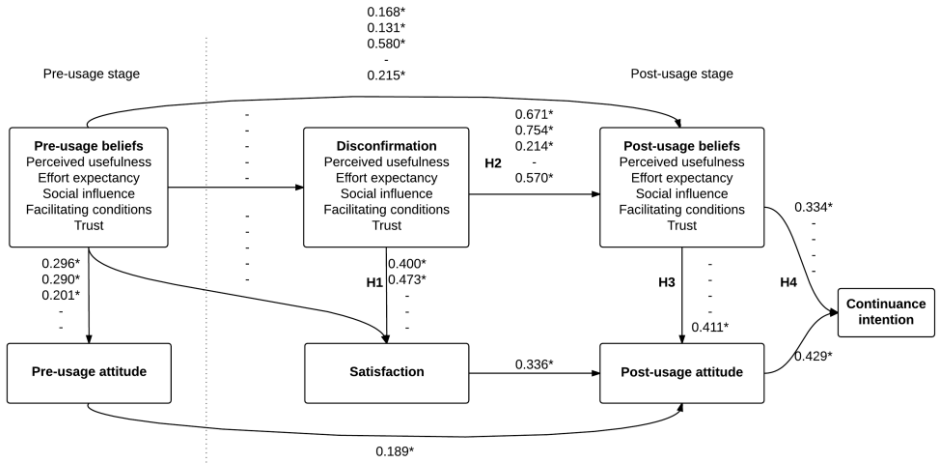

Figure 1: Results with significant paths (*) and non-significant paths (-) for the acceptance and use of open data infrastructures (model adopted from Venkatesh, et al. [22]).

Figure 1 shows that the data provided relatively much support for the second hypothesis, namely that positive disconfirmation of factor X (PU/EE/SI/T) has a

positive influence on post-usage factor X. For instance, we found that positive disconfirmation of effort expectancy has a positive influence on post-usage effort expectancy, and positive disconfirmation of trust has a positive influence on post-usage trust. Positive disconfirmation implies realization of the expectations. For example, if a user of open data infrastructures expected to trust the infrastructure in the pre-usage stage, this was often confirmed in the post-usage stage. Likewise, if the user (i.e. the researcher) did not trust the infrastructure in the pre-usage stage, this was often also the case in the post-usage case. This means that perceived usefulness, effort expectancy, social influence and trust in the pre-usage stage can be used to predict these factors in the post-usage stage. According to the model of Venkatesh et al. [13], post-usage beliefs subsequently influence the intention to continue using the system.

Some support was also found for the first, third and fourth hypothesis, although this support was not as strong as the support for the second hypothesis. With regard to the first hypothesis, the data showed that the positive disconfirmation of effort expectancy has a positive influence on satisfaction. This means that if users of an open data infrastructure expect that the use of the infrastructure will require much effort, this expectation is often realized. Moreover, if they expect that little effort is required, this expectation is realized as well. Regarding the third hypothesis, we found that post-usage influence of trust has a positive influence on post-usage attitude. As far as the fourth hypothesis is concerned, it was found that post-usage influence of perceived usefulness has a positive influence on continuance intention.

In sum, we found that the positive disconfirmation of factor X (PU/EE/SI/T) has a positive influence on post-usage factor X, that the positive disconfirmation of effort expectancy has a positive influence on satisfaction, that post-usage influence of trust has a positive influence on post-usage attitude and that post-usage influence of perceived usefulness has a positive influence on continuance intention. In the following section we will discuss these findings and speculate about their implications.

4. Discussion of the acceptance and use of open data infrastructures

Our findings showed that Perceived Usefulness (PU), Effort Expectancy (EE), Social Influence (SI) and Trust (T) in the pre-usage stage can be used to predict these factors in the post-usage stage. Although the respondents did not receive significant positive or negative confirmation of their initial perceptions while they used one of the open data infrastructures (i.e. the path from the pre-usage stage to the disconfirmation is not significant), it is remarkable that the path from disconfirmation to post-usage beliefs is significant for all factors except for FC. Of all pre-usage belief factors, PU has the largest influence on the pre-usage and post-usage attitude. Also in the relation between post-usage beliefs and post-usage attitude, PU has a significant influence, and PU has a significant influence on satisfaction and the highest influence on the intention to continue using the infrastructure. Thus, out of the variables that we tested, PU seems the most important factor influencing the acceptance and use of open data infrastructures. Examples of measures that governments can take to enhance PU are the training of potential open data users, showing examples of how open data infrastructures can be used, and promoting the use of open data infrastructures through social media.

The positive disconfirmation (i.e. realizing the expectations) of EE has a positive influence on satisfaction. At the same time, EE has a smaller and only indirect effect on

the intention to continue using open data infrastructures than PU does. A possible explanation for this is that the open data users in our sample did not care how much effort it costs to use open data if the PU is high enough. Moreover, most open data users in our sample already had experience with open data use and because of this their effort expectancy did not influence the use of the infrastructure. In our study, SI significantly influences the intention to continue using an open data infrastructure. Looking at the number of significant paths, SI seems to confirm the model most. Although SI has the smallest influence on attitude concerning the use of open data infrastructures compared to PU and EE, the total indirect effect of SI on CI (via pre-usage beliefs and post-usage beliefs) is the largest. This shows the importance of combining technical tools for open data use with support for social aspects. FC was found not to be significant, which means that facilitating conditions, such as tools to support open data use, may not significantly influence a person's intention to continue using open data infrastructures. An alternative explanation is that the internal reliability of the indicators was too low, which might be caused by a misinterpretation of the questions by the respondents. Although trust did not have much influence on the intention to continue using open data infrastructures in our model, we found that post-usage influence of trust has a positive influence on post-usage attitude. In addition, there is an indirect effect of trust on CI (via pre-usage beliefs and post-usage beliefs). Through this indirect effect, governments may influence the acceptance and use of open data infrastructures. Furthermore, governments may influence trust through other factors that have not been examined in our model, such as providing considerable metadata about the context in which the data have been created.

Our study shows that the integrated UTAUT/ECT model provides guidelines for very generic hypotheses. Open data infrastructures may require further specification of these hypotheses. For instance, the factor EE could refer to different types of effort, including effort to find open datasets, effort to interpret the data, effort to receive help with the use of open data or effort to use visualization tools for open data. All these different types of effort may be influenced by other factors. While finding open datasets might cost less effort when a researcher already has prior knowledge of existing open data infrastructures, such knowledge may not influence the use of visualization tools and other types of skills are needed for this. The other constructs (PU, SI, T) also require further specification. For instance, PU may be different for data from different domains in relation to the background, skills and domain of expertise of the data user. Social influence may differ per type of data user, as researchers may be influenced by what their colleagues think while this does not apply for citizens. Trust might be influenced by particular characteristics of the open data infrastructure.

Although a few paths in the model were significant, most paths were not. Our data does not show considerable support for applying the combined UTAUT-ECT model in the context of open data infrastructures. For instance, disconfirmation of the pre-usage beliefs was barely found and hypotheses related to Facilitating Conditions were not significant. A potential explanation for the limited number of significant paths in the model can be the limited number of persons involved in our study (N=145) in comparison to the high number of latent variables. Nevertheless, removing a number of variables to reach a more acceptable ratio did not lead to more significant paths.

The model that we used to examine the acceptance and use of open data infrastructures, developed by Venkatesh, et al. [22], was not focused specifically on open data infrastructures. It concerned Information System in general, although it was used previously in the context of electronic government technologies. Although the

model that combined UTAUT and ECT was helpful, the variables were relatively generic and may need to be specified for the context of open data infrastructures. A model focusing particularly on the context of open data infrastructures may better predict the acceptance and use of such infrastructures than the model of [22] does.

Finally, we assumed that satisfaction, attitude and continuance intention would be indicators of the acceptance and use of open data infrastructures. Since the acceptance and use of open data infrastructures cannot be measured directly through a single variable, we argued that a number of factors can function as indicators for the acceptance and use of open data infrastructures. However, we have not tested the relation between the indicators and the acceptance and use of open data infrastructures. This is an important aspect to consider for future research.

5. Conclusions

This study aims to examine to which extent and by which factors the acceptance and use of open data infrastructures by researchers can be influenced. We evaluated two particular open data infrastructures through surveys using an integrated model of the Unified Theory of Acceptance and Use of Technology (UTAUT) and the two-stage Expectation Confirmation Theory of Information Systems continuance (ECT) of Venkatesh, et al. [22]. Our study showed that meeting the expectations of open data users (i.e. researchers) regarding their effort expectancy for using open data infrastructures was found to have a positive influence on satisfaction (H1). Perceived usefulness, effort expectancy, social influence and trust in the pre-usage stage can be used to predict these factors in the post-usage stage (H2). Moreover, post-usage influence of trust has a positive influence on post-usage attitude towards an open data infrastructure (H3) and post-usage influence of perceived usefulness has a positive influence on the intention to continue using an open data infrastructure (H4).

Not all of our findings show support for applying the combined UTAUT-ECT model of Venkatesh, et al. [22] in the context of open data infrastructures. For example, disconfirmation of the pre-usage beliefs was barely found and hypotheses related to facilitating conditions were not significant. These findings suggest that certain aspects of the combined UTAUT-ECT model need to be specified and adapted for the domain of open data infrastructures. We recommend future research to study whether model adaptations lead to a model that better suits the open data infrastructure domain.

An important question is whether our findings also apply to other samples and to open data infrastructures in general. This study focused on a particular type of open data use, namely the use of structured data on open data infrastructures by researchers. The data concerned the domains of social sciences and humanities and was derived from research by governmental agencies. Moreover, it focused on a particular type of open data use tasks, including finding, analyzing, visualizing, interacting about and assessing the quality of open data. Many other types of open data use are possible, such as open data use by companies, or the use of other types of data, such a geographic data. We recommend future research to examine whether the findings from our study also apply to other contexts, for instance involving other types of open data use, users and data, and to develop models for the acceptance and use of technologies that are more specific to the context of open data.

References

[1] P. Conradie and S. Choenni, "On the barriers for local government releasing open data," *Government Information Quarterly* **31** (2014), S10–S17.

[2] I. Susha, Å. Grönlund, and M. Janssen, "Organizational measures to stimulate user engagement with open data," *Transforming Government: People, Process and Policy* **9** (2015), 181-206.

[3] T. Jetzek, *The sustainable value of open government data. Uncovering the generative mechanisms of open data through a mixed methods approach*. Copenhagen: Copenhagen Business School, 2015.

[4] M. Janssen, Y. Charalabidis, and A. Zuiderwijk, "Benefits, adoption barriers and myths of open data and open government," *Information Systems Management* **29** (2012), 258–268.

[5] B. Detlor, M. E. Hupfer, U. Ruhi, and L. Zhao, "Information quality and community municipal portal use," *Government Information Quarterly* **30** (2013), 23-32.

[6] D. Cowan and F. McGarry, "Perspectives on open data: issues and opportunities," presented at the IEEE International Conference on Software Science, Technology and Engineering, Ramat Gan, Israel, 2014.

[7] O. Hanseth and K. Lyytinen, "Design theory for dynamic complexity in Information Infrastructures: the case of building internet," *Journal of Information Technology* **25** (2010), 1-19.

[8] O. Hanseth. (2004, April 22). *From systems and tools to networks and infrastructures - from design to cultivation. Towards a theory of ICT solutions and its design methodology implications*. Available: http://heim.ifi.uio.no/oleha/Publications/ib_ISR_3rd_resubm2.html

[9] M. Janssen, S. A. Chun, and J. R. Gil-Garcia, "Building the Next Generation of Digital Government Infrastructures," *Government Information Quarterly* **26** (2009), 233–237.

[10] O. Henfridsson and B. Bygstad, "The generative mechanisms of digital infrastructure evolution," *MIS Quarterly* **37** (2013), 907-931.

[11] J. Braa, O. Hanseth, A. Heywood, W. Mohammed, and V. Shaw, "Developing health information systems in developing countries: the flexible standards strategy," *MIS Quarterly* **31** (2007), 381-204.

[12] A. Zuiderwijk, *Open data infrastructures: The design of an infrastructure to enhance the coordination of open data use*. 's-Hertogenbosch: Uitgeverij BOXPress, 2015.

[13] V. Venkatesh, M. G. Morris, G. B. Davis, and F. D. Davis, "User Acceptance of Information Technology: Toward a Unified View," *MIS Quarterly* **27** (2003), 425-478.

[14] M. C. Jurisch, M. Kautz, P. Wolf, and H. Krcmar, "An international survey of the factors influencing the intention to use open government," presented at the 48th Hawaii International Conference on System Sciences, Hawaii, U.S.A., 2015.

[15] A. Bhattacherjee, "Understanding information systems continuance: an expectation-confirmation model," *MIS Quarterly* **25** (2001), 351–370.

[16] A. Bhattacherjee and G. Premkumar, "Understanding Changes in Belief and Attitude Toward Information Technology Usage: a Theoretical Model and Longitudinal Test," *MIS Quarterly* **28** (2004), 229-254.

[17] F. D. Davis, "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," *MIS Quarterly* **13** (1989), 319-340.

[18] F. D. Davis, *A Technology Acceptance Model for Empirically Testing New End-User Information Systems: Theory and Results*. Cambridge: MIT Sloan School of Management, 1986.

[19] R. L. Oliver, "A cognitive model for the antecedents and consequences of satisfaction decisions," *Journal of Marketing Research* **17** (1980), 460–469.

[20] H. Wold, "Partial least squares," in *Encyclopedia of statistical sciences*. vol. 6, S. Kotz and N. L. Johnson, Eds., ed New York: Wiley, 1985, pp. 581–591.

[21] R. D. Tobias, "An introduction to partial least squares regression," in *Proc. Ann. SAS Users Group Int. Conf., 20th, Orlando, FL*, 1995, pp. 2-5.

[22] V. Venkatesh, J. Y. L. Thong, F. K. Y. Chan, P. J.-H. Hu, and S. A. Brown, "Extending the two-stage information systems continuance model: incorporating UTAUT predictors and the role of context," *Information Systems Journal* **21** (2011), 527–555.