

Tackling innovation barriers

An empirical investigation for sustainable transport services

Mobility-as-a-Service, Curiosity, Innovation barriers, Sustainability, Moderated mediation

Whilst there is lots of work on innovation adoption, their barriers often fall short but might be as crucial for the final consumer decision. This study investigates curiosity and its consequences for active or passive innovation barriers on the way towards adoption of a smart mobility service. Curiosity is of interest here as it can function as driver towards striving for novelties. An online sample was drawn ($n = 308$), based on which a moderated mediation model was analysed. It is found that curiosity enhances the evaluation of the service as well as its perceived usefulness and convenience.

Konstantin Krauss

In order to reach the greenhouse gas reduction targets in the transport sector, new and more sustainable mobility services need to be established and, more importantly, used [1]. It is the aim of this study to investigate whether curiosity as a driver towards thinking in new ways and striving for novel events can help to reduce active and passive innovation barriers regarding the usage of more sustainable passenger transport services. In order to answer this question, an empirical study was conducted in Germany, in which $n = 308$ subjects were exposed to a fictional smart mobility service. The moderated mediation model estimated with PROCESS [2] shows that curiosity increases the evaluation, the perceived usefulness and the perceived convenience of the service. Thus, curiosity is not able to tackle passive innovation resistance but is well able to decrease active innovation resistance.

Introduction

One of the most important and recent domains driven by innovative developments is the mobility industry [3]. Therefore, innovation behavior of potential consumers is critical for this industry. This is particularly important with respect to the global climate targets [1; 4]. Although curiosity is said to stimulate exploratory behavior [5], it is very rarely discussed within innovation adoption of new mobility services. The high failure rates of innovations in general – around 40 % [6] – makes it even more necessary to discuss potential factors facilitating innovation adoption behavior. This study shall hence shed further light on the potential role of curiosity towards diffusion of smart mobility by taking an innovation resistance approach [7].

An innovation is defined as „[...] an idea, practice, or object that is perceived as new by an individual or other unit of adoption“. Thereby it does not matter whether this idea is technically new or certain measures define it as new. [8]

Curiosity can be considered as desire that motivates subjects to strive for events that are new or uncertain [9]. Following the definition of an innovation, curiosity might affect the innovation adoption process. Due to the urgency of reducing emissions from transport, sustainability is taken as focus of the advertisement and tested against a neutral focus. In this case, sustainability is understood as the environmental aspects of the triple-bottom line [10]. With respect to the adoption behavior of consumers towards new products or services, innovation resistance particularly focuses on utilizing knowledge about the psychology of resistance in order to develop and promote innovations [7]. This resistance is of critical importance for innovation research because it might hinder consumers in adopting the innovation. Yet, literature about curiosity with respect to innovation resistance in transport is very scarce. Answering the question whether curiosity might mitigate this resistance could be highly beneficial for the society's path towards more sustainable transport.

Smart mobility services (e.g. Whim, Trafi) can be described as a new generation of more intelligent transportation systems and are consequently frequently innovative [11]. Their proposition is defined as a form of mobility that is energy-efficient, low-emission, safe, convenient, affordable and used by traffic participants in an intelligent way [12]. Moreover, it is said to decrease traffic congestion and increase transfer speed [13]. By combining various types of transportation, traditional and new ones, smart mobility is a system of intermodal nexus [12].

Theoretical Background

Curiosity

Curiosity is a feeling of deficiency, arising in a subject from paying focalized attention to a gap in knowledge [14]. The gap itself should be manageable for the subject in order to generate curiosity [14; 15]. “The genesis of cu-

PEER REVIEW – BEGUTACHTET

Eingereicht:
18.02.2020
Endfassung:
30.04.2020

"curiosity" is the subject's transition of focus from "[...] what is known to [...] what is not known". At this point, the information-gap theory predicts the subject to experience an abrupt increase in curiosity. [14] Since the realization of the information-gap induces an aversive feeling of deficiency, the subject is willing to search for information that will close this gap, which makes this process pleasurable. Thus, the specific information that closes the information-gap, and hence satisfies curiosity, functions as reward to influence motivation and learning [16]. The focus on the information aiming to generate curiosity in an advertisement, i.e. on specific features or benefits of the product, is the "curiosity trigger" [15]. With respect to the information-gap, the curiosity trigger functions as goal in order to discover the specific information required to close the gap. Curiosity can furthermore be classified as "desire to change and novelty" [14]. Moreover, it is understood as an "intense desire" striving for "novel, challenging, and uncertain events" [9]. It is furthermore stated that curiosity motivates operating and also thinking in new ways. This exploratory character of curiosity is further conceptualized in the "Optimal Stimulation/Dual Process Theory of Exploratory Behavior". Here, curiosity is considered to stimulate exploratory behavior via an "emotional-motivational system". [5] It could be shown that increased curiosity leads to higher probabilities of innovation adoption [17]. However, the authors measured adoption directly and did not pay particular attention to innovation resistance.

Following these theoretical considerations, the information-gap may induce curiosity, which in turn might influence exploratory behavior and, thus, innovation barriers. Hence, in this functional framework, curiosity might function as mediator between the information-gap and innovation resistance. With respect to additional product information, the specific product goal works as frame for processing and, hence, organizing the information [18; 15].

Innovation Adoption Behavior of Consumers

Adoption of an innovation means making full use of an innovation [8]. Not adopting an innovation can be explained by the concept of innovation resistance. This term was introduced due to a "pro-change bias" in innovation research. Innovation resistance describes the behavior of subjects resisting change and consequently innovations. [7] In order to shed further light on this, the most recent concept of active and passive innovation resistance is applied here [19]. Active innovation resistance refers to characteristics of the innovation. It is intentional due to unfavorable appraisal of the innovation and can thus be found in the persuasion stage of the process of innovation adoption. Passive innovation resistance refers to the imposed changes due to an innovation. This resistance is subject-specific and stems from personal propensities to resist changes and situational factors, which determine the subject's satisfaction with the current status quo. Hence, it can be found in the knowledge stage of the innovation adoption process. [8]

Regarding passive innovation barriers, two factors are of importance: Resistance to change [20] and desirability of control [21; 19]. The former is described as multi-dimensional factor and defined as a subject's "tendency to

resist or avoid making changes" [20]. This resistance reflects a general devaluation of change as well as an aversive perception of change across diverse contexts. Desirability of control is defined as personally exerting control over the subject's surroundings [22].

In the persuasion stage of innovation adoption, attitudes are formed, which are either favorable or unfavorable towards the innovation [8]. Attitudes are the subject's beliefs about a certain object, which predispose its actions and are relatively stable. In this stage, the consumer selects messages and decides about the interpretation of the received information. Consequently, the consumer develops a perception of the innovation, which is selective due to the evaluated decisions concerning messages and their interpretations. This requires forward planning in order to evaluate expected consequences regarding advantages and disadvantages of the innovation. Hence, in the persuasion stage, active innovation resistance plays an important role if consumers evaluate the innovation as negative [19]. Thus, product features, their evaluations and corresponding attitudes towards the innovation are crucial in this stage. The evaluation of product features is measured in terms of how favorable or unfavorable the innovation is to the consumer and is explicitly referred to as active innovation resistance [23]. Perceived usefulness is the perceived likelihood that the product or service creates a benefit for the consumer in performing a particular task [24]. Additionally, complexity refers to how difficult an innovation is to understand and use [23]. Moreover, convenience of a service is understood as the perceptions of consumers towards the time and effort related to buying or using a service [25]. Lastly, perceived risk is another innovation characteristic, which might jeopardize the probability of rewards from the innovation [26].

Condensing the theories and factors outlined above, it is hypothesized that H₁: Curiosity will mediate the effect of the information-gap on the active innovation resistance and on the passive innovation resistance. H₂: With higher magnitudes of curiosity, the active and passive innovation resistance is reduced. These hypotheses are to be tested using a moderated mediation analysis.

Survey and Results

Survey Design

For this study a 2 x 2 full-factorial between-subjects design was applied (information-gap: moderate vs. high x curiosity trigger: sustainability vs. neutral). This design allows controlling and isolating each manipulation effect separately [27]. Data collection took place online in March 2018 with the sample being recruited via German mailing lists and social media channels. The service used in this study was a fictional one in order to exclude direct branding effects from existing services. In principle, it was designed in the way Whim or Trafi work: The user enters origin and destination, subsequently the platform offers routes with various modes of transport to choose and all required tickets are booked with the price being a flat one per month.

The information-gap functioned as curiosity cue and was designed as two-stage factor (moderate vs. high) in a two-stage procedure: In the first stage of the procedure, subjects were exposed to the advertisement including a moderate or high information-gap (*figure 1* exemplarily

shows the high-gap condition). Note that the participants did know they saw an advertisement about a new service but explicitly did not know which kind of service this was until they got to see the resolution, which built the second stage (figure 2). The curiosity trigger was a two-stage factor as well: The sustainability focus referred to the potential of decreasing one's ecological footprint by using this service compared to owning a private car whereas the neutral focus referred to describing the service as new way towards flexibility. Due to the survey design, one participant either saw advertisements with the sustainability focus or with the neutral focus. The study material was pretested with minor changes being made in accordance to these results.

Results

The survey includes $n = 308$ subjects with the different experimental groups being structurally equal as could be tested using χ^2 -tests as well as one-factorial ANOVAs. Furthermore, manipulation checks revealed that all manipulations were successful. Requirements for the subsequent analyses were checked by having no missing data and applying Mahalanobis distances [28].

Results from the moderated mediation model estimated with PROCESS [2] and 5,000 bootstrapping samples can be retrieved from figure 3. It depicts the moderated mediation effects of information-gap on the dependent variables via the mediator curiosity for the neutral curiosity trigger. The coefficients of the regressions are indicated by b . In addition, the conditional indirect effects of the information-gap on the respective depend-

ent variable via curiosity as mediator are shown (indicated by B). All moderated mediation models on the innovation barrier variables are highly significant ($p < 0.001$ throughout).

A partial moderated mediation [29] can be found for the evaluation of

- the service ($B = -0.14$; standard error [SE] = 0.05; 95 % bootstrap confidence interval [CI] = [-0.25;-0.04]),
- perceived usefulness ($B = -0.20$; $SE = 0.09$; 95 % bootstrap $CI = [-0.40;-0.05]$),
- and perceived convenience ($B = -0.15$; $SE = 0.07$; 95 % bootstrap $CI = [-0.30;-0.03]$),

given the neutral curiosity trigger. Thus, significant moderated mediation effects could be shown for three active but none passive innovation barriers. Consequently, curiosity does have an impact on innovation resistance concerning the characteristics of the innovation, which results in a partial confirmation of H1.

When analyzing the regression coefficients of curiosity on the respective innovation barriers (figure 3), the direction of the effects can be evaluated. For the three active innovation barriers that showed a significant moderated mediation effect, the coefficients are positive and significant throughout: for the evaluation of the service $b = 0.15$ ($p < 0.01$), for perceived usefulness $b = 0.22$ ($p < 0.01$) and for perceived convenience $b = 0.17$ ($p < 0.05$). Hence, relatively higher magnitudes of curiosity result in higher evaluations of the service, higher perceived usefulness and higher perceived convenience. The higher values in these three factors transform into reduced active innovation resistance. Consequently, as with H1, H₂ can be partially confirmed.

Regarding innovation behavior of consumers, the results show that curiosity is not able to affect imposed changes an innovation might bring about, i.e. passive innovation resistance. These subject-specific barriers seem to be fostered within the personal propensities in such a way that makes them hard to be influenced by curiosity. However, when consumers evaluate the innovation, curiosity does affect the evaluation results. This makes curiosity a particularly important factor for advertising innovative mobility services within the persuasion stage of the innovation-decision process [8].

Limitations

With respect to generalizability of the study results, limitations have to be critically observed. The sample was drawn by using an online survey, which might make a self-selection bias present in the data [30]. Object of the study was a smart mobility service, which was supplied as an app. This combination might have contradicting effects: On the one hand, a sample drawn online for an app-based mobility service might strengthen the results of the study. On the other hand, the online survey and the service in the form of an app might increase limitation regarding generalizability as it excludes not online-affine subjects by the sampling-procedure and the service. Furthermore, the service was designed as unlimited usage mobility service. This might not reflect the use case for consumers who do not travel regularly or frequently. They might be more interested in a service that offers distinct packages for different users with respect to distance travelled or transportation modes used, and consequently



Figure 1: Stimulus material example with sustainability focus and high information-gap - curiosity-inducing advertisement (first-stage)



Figure 2: Stimulus material example with sustainability focus - resolution advertisement (second-stage)

different prices. The design of the advertisements was evaluated as slightly negative by subjects, which could have also influenced assessment of the service and resulting active and passive innovation resistance.

Conclusion

It is found that curiosity positively influences certain active innovation resistance but does not so with passive innovation resistance regarding a new mobility service. Hence, curiosity functions as accelerator towards active innovation acceptance in this case. As the persuasion stage is also accountable for attitude formation towards the service, curiosity can be seen as actuator for developing more positive attitudes towards a new way of mobility.

These results offer possibilities to derive guidance for practitioners as well as for future research. For new and sustainable mobility solutions to get used by passengers, curiosity can play a crucial role. By increasing curiosity, it could be shown that active innovation barriers can be significantly reduced, which makes it more probable that passengers really use these mobility services. This might be one step towards reducing greenhouse gas emissions from transport. This is because it might cause passengers to not use a private car but shared mobility solutions instead, which shifts the modal split in a productive direction. Future research on smart mobility could also investigate the privacy factor, which might also function as innovation barrier. Moreover, passive innovation resistance could be investigated in more detail by applying more personality-based behavior theories such as the OCEAN model. ■

REFERENCES

- [1] EEA, 2018. Greenhouse gas emissions from transport. European Environment Agency. Available online at <https://www.eea.europa.eu/data-and-maps/indicators/transport-emissions-of-greenhouse-gases/transport-emissions-of-greenhouse-gases-11>, updated on 30.11.2018, checked on 02.12.2018.
- [2] Hayes, A.F., 2013. Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach, The Guilford Press, New York.
- [3] Flügge, B., 2017. Introduction, in "Smart Mobility – Connecting Everyone. Trends, Concepts and Best Practices". In: Flügge, B. (Ed.). Springer, Wiesbaden, pp. 1-3.
- [4] UNFCCC, 2015. Adoption of the Paris Agreement. Edited by United Nations Framework Convention on Climate Change. Available online at <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>, updated on 12.12.2015, checked on 16.12.2018.
- [5] Spielberger, C.D., Starr, L.M., 1994. Curiosity and Exploratory Behavior, in "Motivation Theory and Research". In: O'Neil Jr., H.F., Drillings, M., (Eds.). Erlbaum, Hillsdale, pp. 221-244.
- [6] Castellion, G., Markham, S.K., 2013. Perspective: New Product Failure Rates: Influence of Argumentum ad Populum and Self-Interest. *Journal of Product Innovation Management* 30(5), 976-979.
- [7] Sheth, J.N., 1981. Psychology of Innovation Resistance: The Less Developed Concept, (LDC) in Diffusion Research. *Research in Marketing* 4, 273-282.
- [8] Rogers, E.M., 2003. Diffusion of Innovations, 5th Edition, Free Press, New York.
- [9] Kashdan, T.B., Silvia, P.J., 2009. Curiosity and Interest: The Benefits of Thriving on Novelty and Challenge, in „The Oxford Handbook of Positive Psychology“. In: Lopes, S.J., Snyder, C.R., (Eds.). Oxford University Press, Oxford, pp. 367-375.
- [10] Elkington, J., 1998. Partnerships from Cannibals with Forks. The Triple Bottom Line of 21st-Century Business. *Environmental Quality Management* 8(1), 37-51.
- [11] Chen, Y., Ardila-Gomez, A., Frame, G., 2017. Achieving Energy Savings by Intelligent Transportation System Investments in the Context of Smart Cities. *Transportation Research Part D* 54 381-396.
- [12] Wolter, S., 2012. Smart Mobility – Intelligente Vernetzung der Verkehrsangebote in Großstädten, in "Zukünftige Entwicklungen in der Mobilität". In: Proff, H., Schönharting, J., Schramm, D., Ziegler, J. (Eds.). Gabler, Wiesbaden, pp. 527-548.
- [13] Benevolo, C., Dameri, R.P., D'Auria, B., 2016. Smart Mobility in Smart City. Action Taxonomy, ICT Intensity and Public Benefits, in "Empowering Organizations. Enabling Platforms and Artefacts". In: Torre, T., Braccini, A.M., Spinelli, R., (Eds.). Springer, Cham, pp. 13-28.
- [14] Loewenstein, G., 1994. The Psychology of Curiosity: A Review and Reinterpretation. *Psychological Bulletin* 116(1), 75-98.
- [15] Menon, S., Soman, D., 2002. Managing the Power of Curiosity for Effective Web Advertising Strategies. *Journal of Advertising* 31(3), 1-14.
- [16] Wang, C., Huang, Y., 2018. "I Want to Know the Answer! Give Me Fish 'n' Chips!" The Impact of Curiosity on Indulgent Choice. *Journal of Consumer Research* 44(5), 1052-1067.
- [17] Müller-Stewens, J., Schläger, T., Häubl, G., Herrmann, A., 2017. Gamified Information Presentation and Consumer Adoption of Product Innovations. *Journal of Marketing* 81(2), 8-24.
- [18] Hoffman, C., Houston, M.J., 1993. Goal-oriented Experiences and the Development of Knowledge. *Journal of Consumer Research* 20(2), 190-207.
- [19] Talke, K., Heidenreich, S., 2013. How to Overcome Pro-Change Bias: Incorporating Passive and Active Innovation Resistance in Innovation Decision Models. *Journal of Product Innovation Management* 31(4), 1-14.
- [20] Oreg, S., 2003. Resistance to Change: Developing an Individual Differences Measure. *Journal of Applied Psychology* 88(4), 680-693.
- [21] Burger, J.M., Cooper, H.M., 1979. The Desirability of Control. *Motivation and Emotion* 3(4), 381-393.
- [22] Faraji-Rad, A., Melumad, S., Johar, G.V. 2017. Consumer desire for control as a barrier to new product adoption. *Journal of Consumer Psychology* 27(3), 347-354.
- [23] Heidenreich, S., Spieth, P., 2013. Why Innovations Fail – The Case of Passive and Active Innovation Resistance. *International Journal of Innovation Management* 17(5), 1350021-1 – 1350021-42.
- [24] Kulviwat, S., Brunner II, G.C., Kumar, A., Nasco, S.A., Clark, T., 2007. Toward a Unified Theory of Consumer Acceptance Technology. *Psychology & Marketing* 24(12), 1059-1084.
- [25] Berry, L.L., Seiders, K., Grewal, D., 2002. Understanding Service Convenience. *Journal of Marketing* 66(3), 1-17.
- [26] Meuter, M.L., Bitner, M.J., Ostrom, A.L., Brown, S.W., 2005. Choosing Among Alternative Service Delivery Modes: An Investigation of Customer Trial of Self-Service Technologies. *Journal of Marketing* 69(2), 61-83.
- [27] Koschate, N., 2002. Kundenzufriedenheit und Preisverhalten. Theoretische und empirisch experimentelle Analysen, Springer, Wiesbaden.
- [28] Field, A., 2013. Discovering Statistics Using IBM SPSS Statistics. And Sex and Drugs and Rock 'n' Roll, 4th ed., Sage Publications, London.
- [29] Baron, R.M., Kenny, D.A., 1986. The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Considerations. *Journal of Personality and Social Psychology* 51(6), 1173-1182.
- [30] Homburg, C., 2017. Marketingmanagement. Strategie – Instrumente – Umsetzung – Unternehmensführung, 6th ed., Springer Gabler, Wiesbaden.

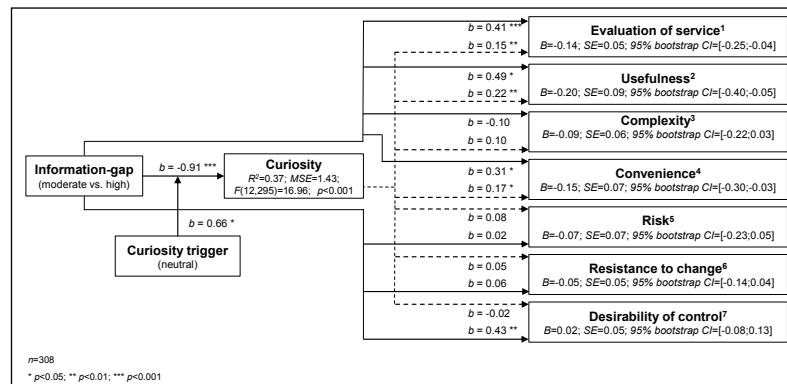


Figure 3: Results from moderated mediation analysis of curiosity on active and passive innovation resistance

¹ $R^2 = 0.35$; $MSE = 0.85$; $F(11,296) = 13.88$; $p < 0.001$

² $R^2 = 0.34$; $MSE = 2.54$; $F(11,296) = 17.46$; $p < 0.001$

³ $R^2 = 0.10$; $MSE = 1.49$; $F(11,296) = 3.09$; $p < 0.001$

⁴ $R^2 = 0.33$; $MSE = 1.87$; $F(11,296) = 14.07$; $p < 0.001$

⁵ $R^2 = 0.10$; $MSE = 2.20$; $F(11,296) = 3.61$; $p < 0.001$

⁶ $R^2 = 0.29$; $MSE = 1.05$; $F(11,296) = 13.20$; $p < 0.001$

⁷ $R^2 = 0.14$; $MSE = 1.19$; $F(11,296) = 4.21$; $F < 0.001$

Moderation model: $R^2 = 0.38$; $MSE = 1.42$; $F(14,287) = 14.49$; $p < 0.001$

[14] Loewenstein, G., 1994. The Psychology of Curiosity: A Review and Reinterpretation. *Psychological Bulletin* 116(1), 75-98.

[15] Menon, S., Soman, D., 2002. Managing the Power of Curiosity for Effective Web Advertising Strategies. *Journal of Advertising* 31(3), 1-14.

[16] Wang, C., Huang, Y., 2018. "I Want to Know the Answer! Give Me Fish 'n' Chips!" The Impact of Curiosity on Indulgent Choice. *Journal of Consumer Research* 44(5), 1052-1067.

[17] Müller-Stewens, J., Schläger, T., Häubl, G., Herrmann, A., 2017. Gamified Information Presentation and Consumer Adoption of Product Innovations. *Journal of Marketing* 81(2), 8-24.

[18] Hoffman, C., Houston, M.J., 1993. Goal-oriented Experiences and the Development of Knowledge. *Journal of Consumer Research* 20(2), 190-207.

[19] Talke, K., Heidenreich, S., 2013. How to Overcome Pro-Change Bias: Incorporating Passive and Active Innovation Resistance in Innovation Decision Models. *Journal of Product Innovation Management* 31(4), 1-14.

[20] Oreg, S., 2003. Resistance to Change: Developing an Individual Differences Measure. *Journal of Applied Psychology* 88(4), 680-693.

[21] Burger, J.M., Cooper, H.M., 1979. The Desirability of Control. *Motivation and Emotion* 3(4), 381-393.

[22] Faraji-Rad, A., Melumad, S., Johar, G.V. 2017. Consumer desire for control as a barrier to new product adoption. *Journal of Consumer Psychology* 27(3), 347-354.

[23] Heidenreich, S., Spieth, P., 2013. Why Innovations Fail – The Case of Passive and Active Innovation Resistance. *International Journal of Innovation Management* 17(5), 1350021-1 – 1350021-42.

[24] Kulviwat, S., Brunner II, G.C., Kumar, A., Nasco, S.A., Clark, T., 2007. Toward a Unified Theory of Consumer Acceptance Technology. *Psychology & Marketing* 24(12), 1059-1084.

[25] Berry, L.L., Seiders, K., Grewal, D., 2002. Understanding Service Convenience. *Journal of Marketing* 66(3), 1-17.

[26] Meuter, M.L., Bitner, M.J., Ostrom, A.L., Brown, S.W., 2005. Choosing Among Alternative Service Delivery Modes: An Investigation of Customer Trial of Self-Service Technologies. *Journal of Marketing* 69(2), 61-83.

[27] Koschate, N., 2002. Kundenzufriedenheit und Preisverhalten. Theoretische und empirisch experimentelle Analysen, Springer, Wiesbaden.

[28] Field, A., 2013. Discovering Statistics Using IBM SPSS Statistics. And Sex and Drugs and Rock 'n' Roll, 4th ed., Sage Publications, London.

[29] Baron, R.M., Kenny, D.A., 1986. The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Considerations. *Journal of Personality and Social Psychology* 51(6), 1173-1182.

[30] Homburg, C., 2017. Marketingmanagement. Strategie – Instrumente – Umsetzung – Unternehmensführung, 6th ed., Springer Gabler, Wiesbaden.



Konstantin Krauss, M. Sc.

Nachhaltigkeit und Infrastruktursysteme, Fraunhofer-Institut für System- und Innovationsforschung ISI, Karlsruhe

konstantin.krauss@isi.fraunhofer.de