

# **Stakeholder management in complex innovation processes**

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Julia Kroh, Master of Science  
aus Rinteln

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Erstbegutachtung:

Prof. Dr. Carsten Schultz

Zweitbegutachtung:

Prof. Dr. Stefan Hoffmann

Drittbegutachtung:

Prof. Dr. Hans Koller

Tag der mündlichen Prüfung:

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„Zwar weiß ich viel, doch möcht' ich alles wissen.“

*Auszug aus Goethes „Faust. Eine Tragödie“*

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## **Abstract**

Addressing major global challenges, such as climate change, requires innovative solutions that could affect various business sectors and institutions. In this context, the importance of the urban space as an innovation object increases, because this space, as a center of social life, and financial and industrial activities, includes large consumers of resources and energy. Consequently, innovations that address innovative urban restructuring are complex. They are developed in a multi-stakeholder ecosystem, where the creation, combination, and recombination of knowledge are distributed among heterogeneous ecosystem stakeholders. Thus, an organization must have specific capabilities to develop complex innovations in such close multi-stakeholder collaborations involving unknown interactions and producing unpredictable reactions like stakeholder opposition. Furthermore, multi-stakeholder ecosystems require new project management approaches. Therefore, this cumulative PhD thesis aims to reveal the mechanisms and contingencies of these stakeholder-related innovation processes, as seen from the perspective of the organization (i.e., organizational capabilities for multi-stakeholder management) and the ecosystem (i.e., project management of the multi-stakeholder collaborations).

The results of this PhD thesis emphasize that complex innovations, such as service and urban innovations, rely on flexible and adaptive stakeholder collaboration. Complex innovations have high information requirements that organizations meet through IT, as a structural mechanism for ecosystem stakeholders' information processing. Intensive IT use positively influences the performance of complex innovation, but organizations have problems establishing IT infrastructures and using digital tools for internal and external stakeholder involvement. Although digital tools encourage stakeholder information gathering and processing through intensive stakeholder involvement, they also increase the need to coordinate broad stakeholder involvement in urban innovation. Further, the innovativeness and implementation of urban innovations profit from intensive stakeholder involvement, but only if the involved stakeholders are well-chosen since too broad stakeholder involvement may produce the opposite result. However, the attitude of stakeholders is a criterion to prioritize them and emphasizes the importance of a constructive opposition. Skeptical stakeholder involvement increases the degree of innovativeness and the implementation of the innovation. Moderate levels of formal management support (skeptical) stakeholder involvement, but too high levels of formalization hamper the development of an absorptive capacity.

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**List of abbreviations**

$\beta$	Standardized regression coefficient
CAS	Complex adaptive system
F	F-value (ratio of the mean regression sum of squares divided by the mean error sum of squares)
$f^2$	Cohen's f (effect size, strength of relationship between variables)
fsQCA	Fuzzy-set qualitative comparative analysis
H	Hypothesis
HTMT	Heterotrait-monotrait ratio of correlations
ICC	Intraclass correlation coefficient
ICC (1, k)	Method for calculation of ICC (one-way random, average score of a different set of k randomly selected raters)
IHIP	Intangibility, heterogeneity, inseparability, and perishability (service characteristics)
IT	Information technology
p	p-value (strength of evidence)
PLS	Partial least squares
QCA	Qualitative comparative analysis
R&D	Research and development
$R^2$	Explained variance
ROA	Return on assets
ROE	Return on equity
ROS	Return on sales
RQ	Research question
t	t-value (precision of the regression coefficient measure)
S.D.	Standard deviation

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## 1 Motivation

Addressing major global challenges, such as climate change, requires innovative solutions that inevitably affect various business sectors and institutions (Fagerberg, 2017; Rousseau et al., 2019). These innovative solutions can only be implemented with the support of multi-stakeholder collaboration including the local government, businesses, research institutes, civil societies, and citizens (Bode et al., 2019; United Nations, 2019). In this context, the importance of the urban space as an innovation object increases, because it is a locus of high consumers of resources and energy and a center of social life, and financial and industrial activities (Joss, 2015; Coalition for Urban Transition, 2019). Concurrently, organizations recognize the favorable business prospects presented by innovative urban restructuring, also known as urban innovations for sustainable urban development (e.g., Mieg, 2012; Gutzmer, 2016). However, no single organization or small group of organizations can innovate on its own, not only because knowledge is dispersed across the stakeholder groups, but also because the components of many new products, services, and processes cause unknown interactions and unpredictable reactions like stakeholder opposition (Dougherty and Dunne, 2011; Yu et al., 2017). Obviously, the capabilities of an organization to develop these complex innovations differ from the required capabilities for innovation development that do not rely on multi-stakeholder collaboration. Furthermore, multi-stakeholder ecosystems may require new project and ecosystem management approaches (e.g., Luetjen et al., 2019). In response, the aim of this cumulative PhD thesis is to uncover the mechanisms and contingencies of complex stakeholder-related innovation processes from the perspective of the organization (i.e., organizational capabilities for multi-stakeholder management) and the ecosystem (i.e., project management of the multi-stakeholder collaborations).

From an innovation management perspective, it is necessary to investigate urban innovations because of their compelling ecological, social, and practical relevance. Globally, more people live in urban areas than in rural areas, and cities must change dramatically to counter climate change (United Nations, 2018). Consequently, the efficient development and implementation of urban innovations, like encouraging climate-friendly mobility, building climate-neutral houses, and creating green spaces, are crucial (e.g., Probst, 2019). Recent research on urban innovation focused mainly on governance mechanisms and was published mainly in public governance and urban planning literature. From the research it is evident that the term ‘urban innovation’ is used in different ways

and lacks differentiation. For example, urban innovation is the outcome of innovation activities in a city, often represented by the sum of new products, processes, and services in an urban ecosystem and by the number of patent applications in a city (e.g., Ning et al., 2016). A city can also establish a competitive and challenging environment through its governance and policies (Caragliu et al., 2016; Caragliu and Del Bo, 2019). Even so, urban innovation also incorporates any kind of urban restructuring, including the implementation of new governance and communication channels and the restructuring or renovation of urban districts. Therefore, the urban is the objective of innovation activities (Yigitcanlar, 2009; Mieg, 2012). This dissertation subscribes to the latter understanding of urban innovation.

Urban innovation demonstrates in an exemplary way that the development and implementation of complex innovations require many stakeholders (e.g., Khomsi, 2016; Nilssen, 2019). Presently, stakeholder perspective is important, since organizations shift their business focus toward stakeholder-centric business models. Apart from allowing the development of a long-term stakeholder relationship, it also presents the possibility of long-term profits, among others for services (e.g., Neely, 2008; Storey and Larbig, 2018). However, recent research shows that organizations experience problems when they involve stakeholders in, for example, the development of new services, because of the tacit knowledge and heterogeneity of the customers (e.g., Kroh et al., 2018). Innovation complexity and stakeholder collaboration problems increase when organizations address major challenges, like climate change, which are driven by public parties and which, in addition, rely on a stakeholder ecosystem – including all city stakeholders – more heterogeneous than the service ecosystem. For example, the more heterogeneous the stakeholder ecosystem, the higher the probability that skeptical stakeholders will not necessarily support the innovations (Edwards-Schachter, 2018), even though collaboration can result in the endorsements of goals (Williams et al., 2019) and a lasting stakeholder commitment (Hertel et al., 2019). Both the endorsement of goals and stakeholder commitment have a positive effect on innovation performance (e.g., Harrison et al., 2010). The fact that urban innovation inevitably has an impact, provides the opportunity to investigate the influence of skeptical stakeholders on innovation success.

Complexity arises in innovation processes, because they are coevolutionary, relational, intertemporal, and cultural, and this complexity increases when facing external challenges (Senge et al., 2007; Dougherty and Dunne, 2012; Garud et al., 2013). Therefore, complex

innovation processes always involve multiple levels of analyses since various stakeholders interact with and react unpredictably to the actions of others over considerable periods of time (e.g., Murmann, 2003; Garud et al., 2011). From an ecosystem perspective it is essential to manage these stakeholders for a common innovation purpose, also considering that this requires different capabilities (e.g., Lundvall, 2013). According to Dougherty and Dunne (2011), organizations that develop complex innovations are characterized by operating knowledge capabilities, ongoing strategizing, and public policy development in the ecosystem. These organizations must have established processes to generate and transfer knowledge in their specific environment, a long-term strategy that involves ecosystem stakeholders, and an interest in developing policies to reduce the perceived ambiguity of the stakeholders. Knowledge capabilities rely on the ability to gather information from the ecosystem's stakeholders and to process this in the organization (e.g., Galbraith, 1974; Tushman and Nadler, 1978; Dente et al., 2005). Furthermore, this process relies on a structural framework that enables the organization to coordinate the external information gathering from stakeholders and the internal processing of stakeholder information (e.g., Turkulainen et al., 2015). However, information processing and coordination mechanisms in complex innovation processes have not been clarified by recent innovation management research and there is a call for integrated research (e.g., Dougherty, 2017). Therefore, from the ecosystem orchestrating perspective, the aim of this research is to investigate the capabilities organizations must employ in complex innovations, like service and urban innovation, and the mechanisms that underlie these innovations.

Stakeholders are a key resource of innovation because their involvement promotes high innovation performance in complex innovation processes (e.g., Juntunen et al., 2019), therefore implying that stakeholder information is the main driver of innovation and builds an organization's knowledge capabilities. Stakeholder information and its processing reduce the uncertainty inherent to innovation processes and, therefore, the development of an information processing capability is crucial for organizations (Galbraith, 1974; Tatikonda and Montoya-Weiss, 2001; Silva et al., 2019). The literature emphasizes the use of information technology (IT) as a structural mechanism to increase an organization's information processing capability and to involve a large number of stakeholders (e.g., Ben-Arieh and Pollatscheck, 2002; Zahay et al., 2011). IT increases both external and internal information processing capabilities. IT-based involvement tools, like social media, online

idea sourcing, and web-based toolkits, increase the external information processing capability and facilitate stakeholder involvement (e.g., Von Hippel, 2001; Veldhuizen et al., 2006; Marion et al., 2014). Internal information processing capabilities increase with IT-based tools that coordinate the innovation activities in the organization and support inter-organizational stakeholder collaboration, such as idea management software and decision support systems (e.g., Gann and Salter, 2000; Schultz et al., 2019a). Regarding the use of IT tools, previous research emphasized their importance, for example, for service innovations (e.g., Plattfaut et al., 2015), but also identified several challenges resulting from stakeholder heterogeneity and the tacit knowledge these innovations rely on (Jaakkola et al., 2017). This implies that the use of IT and its performance impact are dependent on the firm's business focus. Prior research has, thus far, not considered this aspect, despite the increasing importance of service innovations (e.g., Kowalkowski et al., 2017). Given service innovations' complexity, the influence of IT on internal and external stakeholder involvement may differ, although organizations require both for successful innovation development. Thus, the first research question is:

*Research question 1: How do organizations gather, and process information obtained from internal and external stakeholders in complex innovation processes like service innovation?*

Several studies investigated stakeholder involvement capabilities from the perspective of an organization, but only a few of them investigated stakeholder involvement in ecosystems (e.g., Desai, 2018; Li et al., 2018). Urban innovation, in particular, is still an under-researched topic (e.g., Lindkvist et al., 2019; Da Silva et al., 2019) and, at present, the most influential stakeholder groups and their involvement in these innovation processes are unknown. Cities are complex and adaptive ecosystems characterized by constant underlying change. For example, the establishment of complex system innovations, like energy-efficient heating and mobility infrastructures, is associated with the involvement of a city's administration, the local energy utility, planning offices, real estate companies, industry, private homeowners, and residents to resolve information asymmetries and to align innovation activities with stakeholders' needs (e.g., Caragliu et al., 2016; Planko et al., 2017). This brings many possibilities of innovation resistance to bear on the individual, organizational, and ecosystem levels, and the overcoming of these innovation barriers advances the success of urban innovations. Although it is well known that many different stakeholders are relevant to urban innovation, it is not clear which key stakeholder groups



are relevant to which specific implementations and how these groups interact. Therefore, dedicated qualitative and explorative research is required to extend the understanding of the urban innovation research field and to support theory-building and theory-elaboration (Edmondson and McManus, 2007; Arino et al., 2016; Fisher and Anguinis, 2017). The second research question is:

*Research question 2: Which mechanisms underlie, and which success factors encourage complex innovation processes like urban innovation projects?*

The involvement of many stakeholder groups may lead to coordination problems and losses in efficacy and efficiency (e.g., Harrison and Bosse, 2013; Garcia-Castro and Francoeur, 2016). Involving heterogeneous stakeholders in urban innovations may also require compromises regarding the object of innovation, the degree of innovativeness, and the implementation rate, as the specific objectives of each individual stakeholder may contradict those of others (e.g., Bengtsson et al., 2015). Both the degree of innovativeness and the eventual implementation are achievable in urban innovation projects, although these aspects may also contradict each other. A high degree of innovativeness in urban innovation is important as, for example, the application of new technologies is fundamental to addressing the current ecological needs of cities. However, the development of innovation alternatives only affects energy efficiency when these alternatives are implemented in urban areas (e.g., Farías and Bender, 2010; Nielsen et al., 2019). Furthermore, the involvement of stakeholders may be a double-edged sword (e.g., Watson et al., 2018), thus requiring stakeholder involvement strategies. Especially in large stakeholder ecosystems, like urban innovation projects, multiple interests need to be governed, also considering that reservations, criticism, and opposition may arise (e.g., Kazadi et al., 2016; Di Maddaloni, and Davis 2017). The consequences of the involvement of these skeptical stakeholders in complex innovation processes have, until now, been largely neglected in research, although they can have a significant influence on urban innovation success. Only a few qualitative studies cover the aforesaid (e.g., Liu et al., 2018; Yu et al., 2019), thus justifying the need for quantitative research. Furthermore, stakeholders' attitude may not necessarily have a negative impact. Skeptical stakeholders, as a constructive opposition, can challenge the developed innovation alternatives, thereby exceeding current standards and increasing the degree of innovativeness (e.g., Hauschildt, 1999; Markham, 2000). At the same time, active participation in the innovation development process can increase skeptical stakeholders' willingness to implement

innovations. Regarding the large number and heterogeneous nature of stakeholders, an increase in their prioritization and their involvement capabilities are recommended to comply with the information processing requirements and capabilities of organizations or project teams that develop urban innovations. Therefore, the third and fourth research questions are:

*Research question 3: How do urban innovation projects profit from (a) stakeholder involvement breadth and (b) stakeholder involvement depth?*

*Research question 4: How does skeptical stakeholder involvement influence urban innovation projects' success?*

## **2 Theoretical and conceptual background**

Complex innovations are innovations generated in an ecosystem, where the creation, combination, and recombination of the necessary innovation knowledge is distributed among ecosystem stakeholders (McCarthy et al., 2006; Dougherty and Dunne, 2011). A stakeholder is therefore defined as any group or individual directly affected by the innovation's purpose (Freeman, 2010). Both service innovations and urban innovations comply with these characteristics. Service design is dependent on interaction with heterogeneous customers, because its design and consumption is inseparable, thereby comprising a complex service ecosystem (Fitzsimmons and Fitzsimmons, 2008). Furthermore, services are inseparable and perishable (Den Hertog et al., 2010). Innovative urban restructuring relies on organizational, policy, and technological innovations, all of which contribute to the construction of a redesigned urban space, along with the involvement of the public sector, residents, industry, and other stakeholder groups (Nam and Pardo, 2011; Nilssen, 2019). The development and implementation of these system innovations inevitably result in complexity.

Given the influence of stakeholders on complex innovations, information processing and coordination are essential capabilities (e.g., Palmberg, 2009). However, information gathering is difficult because stakeholders are partly connected to one another in self-organizing networks through, for example, feedback loops (e.g., Rogers et al., 2005). Among others, stakeholders may be connected through customer-supplier relationships (e.g., energy utilities, housing companies, and residents in urban ecosystems) and neighborhood associations in urban ecosystems. Further, the stakeholders react to one another in, for example, processes of emergence and feedback and, as a result, the whole ecosystem self-organizes and coevolves (Reiman et al., 2015). Additionally, stakeholders who enter and leave the system complicate the information gathering process, thereby increasing innovation complexity.

Furthermore, stakeholders have experienced a process of institutionalization, which over the years, has provided them with increased legitimacy, available resources, and ecosystem-specific capabilities (Scott, 1987; Landry, 2012). Consequently, there is little motivation for these stakeholders to adapt to change and, thereby, to adopt complex innovations. This results in innovation resistance, which complicates stakeholder coordination and information processing. As a response to this predicament, stakeholder coordination aims at gathering stakeholder information, organizing the innovation

development process along with stakeholder involvement, and encouraging stakeholder investments in complex innovations for sustainable urban development. The coordination of information gathering processes facilitates the development of innovation alternatives based on stakeholders' needs, and can induce a process of institutional change supported by regulatory (rewards and sanctions) and normative (values and norms) pressure (Berrone et al., 2013; Metz et al., 2016).

However, especially in complex settings, stakeholder opposition can hamper information processing and coordination (e.g., Yu et al., 2017; Yu et al., 2019). Skeptical stakeholders could change the scope of the projects, delay, and even entirely block projects. The involvement of skeptical stakeholders may have a detrimental effect on efficiency and efficacy (e.g., Bengtsson et al., 2015). Irrespective, skepticism is also a source of innovative ideas (Hauschildt, 1999) and increases the quality of innovations by broadening the knowledge base for innovation development (e.g., Juntunen et al., 2019). Constructive opposition, in the form of receiving constructive feedback, reduces stakeholder conflicts and thus increases project efficiency (Elias, 2016). Drawing on instrumental stakeholder theory (e.g., Jones et al., 2018), stakeholder attitude – assuming that skeptical stakeholder are involved instead of ignored – can serve as a prioritization criterion that increases innovation performance. Furthermore, the involvement of skeptical stakeholders can have a signaling effect on other stakeholders and increase overall innovation acceptance. This will prevent other stakeholders from delaying or boycotting innovation (e.g., DuFour et al., 2019), and contribute to higher implementation rates (Olsen et al., 2016; Grimpe et al., 2019; Lindkvist et al., 2019).

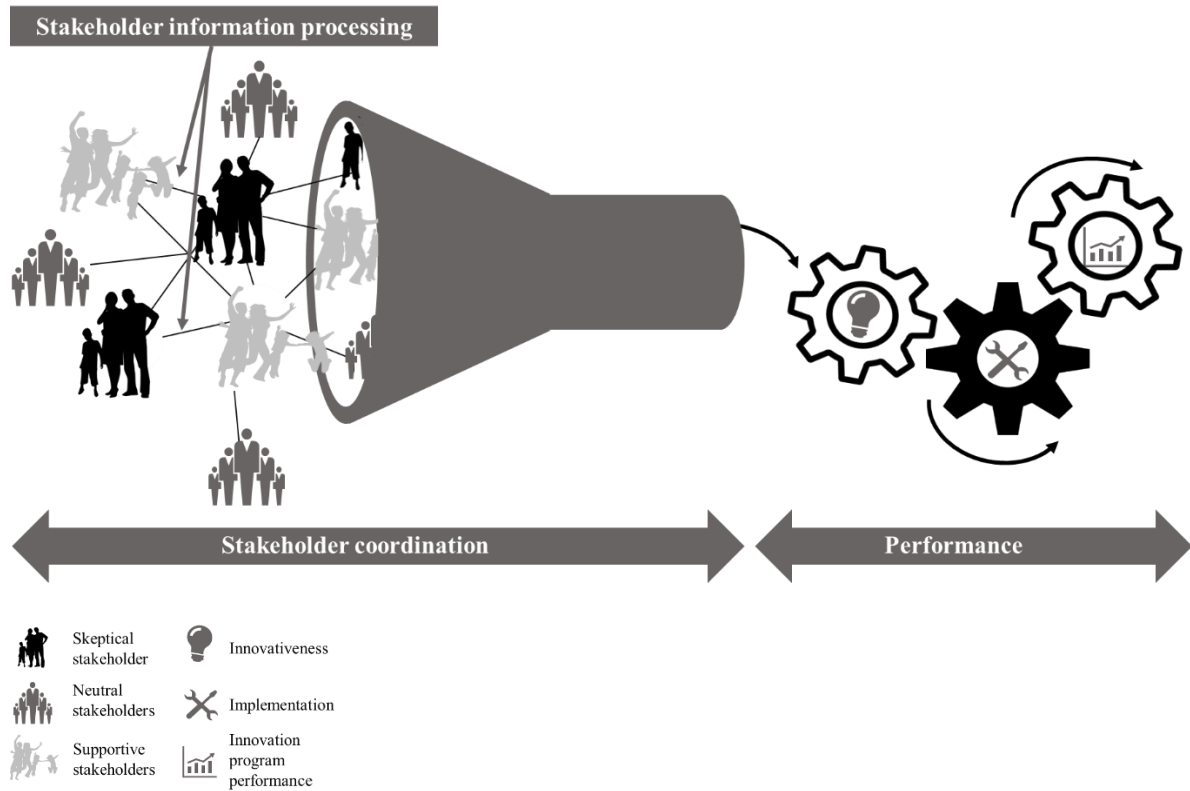
Coordination in the form of formal structures, such as the assignment of clear responsibilities, tasks, and milestones, supports stakeholder coordination by accounting for their heterogeneous goals, and by facilitating the development of heterogeneous innovation alternatives in complex innovation projects (e.g., Gann and Salter, 2000; Davies and Hobday, 2005, Widén et al., 2013). Coordination eases the information processing process within an organization or a project team. However, in the event of a high level of formalization, the result may be the exact opposite (Aggeri and Segrestin, 2007). Formal management methods can obstruct the absorption of stakeholders' contributions because it is impossible to handle heterogeneous and inconsistent information when processes are too rigidly defined (e.g., Schultz et al., 2019a; Schultz et al., 2019b). The intensive involvement of stakeholders, particularly, requires spontaneous communication with stakeholders; a

prerequisite that calls for high process flexibility. In addition, high formalization decreases a project team's absorptive capacity, which in general is positively associated with performance and essential to develop the required knowledge capabilities (e.g., Lane and Lubatkin, 1998; Dougherty and Dunne, 2012).

Established performance measures, like innovation performance, may be inappropriate for urban innovations because of the long implementation horizon and uncertain financial rewards of these innovations. Whereas an organization can measure the impact of product and service innovations on innovation performance, the rewards of participating in the development of system innovations, for example the establishment of mobility solutions in a stakeholder ecosystem, could be uncertain. Therefore, different performance measures that indicate innovation success are necessary. First, high degrees of innovativeness account for future needs and hold the probability of ecosystem persistence and, therefore, innovations with higher degrees of innovativeness promise greater future change. The degree of innovativeness indicates the potential of the innovation and is a priority indicator of the prospective financial performance of complex innovations and it mirrors their explorative character. Second, the implementation of an innovation is the key success factor in innovation development and is influenced by various factors such as the match between the innovation and the stakeholders' expectations, and an effective implementation process (Klein and Sorra, 1996; Real and Poole, 2015). In urban innovation, only realized innovation alternatives generate a sustainability impact and thus fulfill the ecosystem's goals. Nevertheless, because of the exploitative character of implementation, innovativeness and implementation can be contradictory. However, according to previous research (e.g., Uotila et al., 2009), complex innovation development needs both exploration and exploitation to guarantee sustainable urban development. Third, the innovation program performance indicates how an organization's innovation activities contribute to its success. The innovation program performance is a firm-wide performance indicator of the success of ecosystem innovations. These three measures are interdependent. When stakeholders adopt innovative solutions because of their newness, they ensure market and ecosystem diffusion, thereby contributing to the organization's profit.

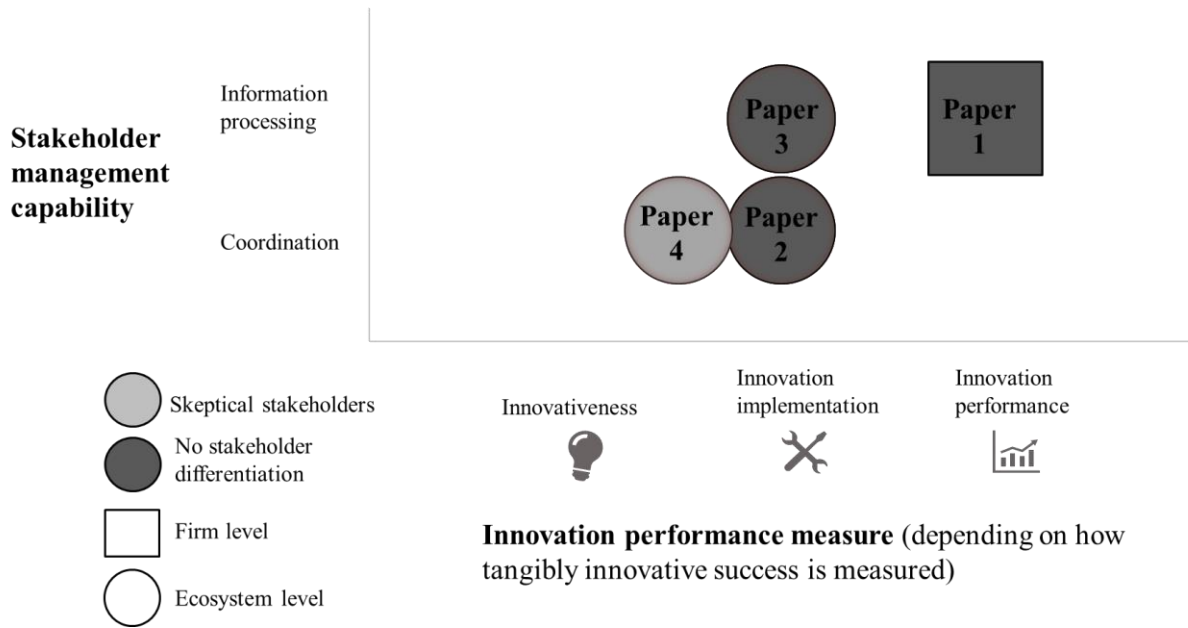
Figure 1 summarizes and depicts the relationship between stakeholder management capabilities and innovation success. Stakeholder information processing (all links between heterogeneous stakeholder groups) and stakeholder coordination (both the management of

the stakeholder network and the funnel) result in innovative solutions, which in their final implementation stage, eventually contribute to an increase in innovation performance.



**Figure 1. Conceptual framework**

This dissertation investigates the underlying mechanisms and contingencies of the complex innovation process, presented in Figure 1, in four research articles. Figure 2 summarizes the papers by indicating the interdependencies of stakeholder management capabilities and innovation performance measures. One paper addresses the firm level, whereas the other three papers address the ecosystem level. The ecosystem level complements the research on stakeholder management capabilities on the firm level (e.g., Flammer and Kacperczyk, 2016; Li et al., 2018), and gives special attention to the fuzziness of stakeholders in ecosystems. Table 1 shows the publication details of the four papers.



**Figure 2. Research articles in the conceptual framework**

**Table 1. Overview of the publication details of the papers**

Article	Title	Publication Status	Author(s)
<b>Paper 1</b>	Use and efficacy of information technology in innovation processes: The specific role of servitization	Published 2018 in Journal of Product Innovation Management, 35(5), 720-741. DOI: <a href="https://doi.org/10.1111/jpim.12445">https://doi.org/10.1111/jpim.12445</a> 2-year-impact 3.781, VHB-Ranking: A	Kroh, J., Luetjen, H., Globocnik, D. Schultz, C.
<b>Paper 2</b>	Sustain(able) urban (eco)systems: Stakeholder-related success factors in urban innovation projects	Working Paper Under Review: European Academy of Management Conference	Kroh, J.
<b>Paper 3</b>	The more the better? The role of stakeholder involvement and digital tools in urban innovation projects	Working Paper Under Review: Academy of Management Conference	Kroh, J. Schultz, C.
<b>Paper 4</b>	Cooperating with the opposition: The influence of skeptical stakeholder involvement on urban innovation projects' innovativeness and implementation	Working Paper	Kroh, J. Schultz, C.

### 3 Methods

This dissertation is based on different methodologies in order to assess stakeholder management capabilities and innovation performance measures on the firm and ecosystem level. Table 2 provides an overview of the empirical studies published in papers that relate to the research questions of this dissertation. The major part of this dissertation is based on an in-depth investigation of urban innovation projects, as an example of ecosystem-based, complex innovation projects.

**Table 2. Studies of the dissertation's mixed-method approach**

<b>Research question</b>	How do organizations gather, and process information obtained from internal and external stakeholders in complex innovation processes like service innovation?	Which mechanisms underlie, and which success factors encourage complex innovation processes like urban innovation projects?	Which urban innovation performance measures can be used to evaluate urban innovation project success?	How do urban innovation projects profit from (a) stakeholder involvement breadth and (b) stakeholder involvement depth? How does skeptical stakeholder involvement influence urban innovation projects' success?
<b>Method</b>	Survey on innovation management capabilities involving 116 firms from, e.g., manufacturing and energy supply, with on average 7.65 informants per firm	20 semi-structured and 26 structured interviews of project teams for the development and implementation of urban innovations	Analysis of 169 urban innovation planning documents via text mining and text analysis	Survey on project management and stakeholder involvement involving 107 urban innovation project teams
<b>Study</b>				

#### 3.1 Case urban innovation projects

The dissertation builds on data obtained from a public-funded, German urban innovation initiative, with the goal of increasing energy efficiency and decreasing carbon emissions through the transformation of existing urban space. Therefore, the related



projects are aimed at developing and implementing innovation alternatives to transform well-established city districts into low-carbon and energy-efficient green districts like the French initiative *ÉcoQuartier* (Joss, 2015). At the point of data collection, about 600 of these initiatives were financed by the same funding program. This means that their goals and the list of potential innovation alternatives for all the districts were similar (Bundesministeriums des Inneren, für Bau und Heimat, 2018). It was therefore possible to investigate urban innovation independently of the type of innovation project. Innovation development and implementation management must be funded separately, and projects for which innovation alternatives are developed do not necessarily receive funding for implementation management.

Only public institutions, like urban public entities, could apply for public funding. As a result, these organizations were responsible for coordinating the development and implementation of the innovations. After funding was granted, a project team developed innovation alternatives for innovative urban restructuring in specific districts of small, medium-sized, and large cities. The project teams consisted of two to ten different organizations representing, for example, public institutions, energy providers, real estate companies, and planning offices. The funding guidelines included, but were not limited to an in-depth investigation of a city district's initial situation, the development of concrete alternatives, and the mobilization, information, and extensive consultation of stakeholders (Kreditanstalt für Wiederaufbau, 2019). Stakeholder analysis and involvement is an integral part of urban innovation projects. This dissertation defines the term 'stakeholders' as groups or individuals, for example representing private homeowners, industry, inhabitants, or public institutions, actively involved in and affected by urban innovation activities. Following the innovation development, the project teams summarized these innovation alternatives in a written planning document, embodying their concept for implementation. At a later stage, this project team initiated the implementation of urban innovations allowing the involvement of other stakeholder groups. Because the implementation of these system innovations has a long time horizon, the dissertation focuses on the front end of urban innovation development.

### **3.2 Data samples and analyses**

This dissertation builds on two different data samples. First, survey data from a cross-sectional industry sample of German and Austrian firms are used to answer research question 1. Therefore, senior firm managers and a group of employees who daily work with innovation tasks were invited to participate in the survey. Subsequently, they each received a link to an online survey, which included the items to be assessed. A different survey was sent to one senior executive of each business unit to capture the overall innovation program performance and the firm's business focus, that is the degree of servitization, since the latter requires a representative overview of the organization's activities and outcomes. By using different participants, this multiple respondent design reduced the likelihood of common method bias. In total, 887 informants from 116 firms (an average of 7.65 participants per firm) answered the survey questionnaire.

Second, an in-depth analysis of 169 German urban innovation projects is used to answer research questions 2, 3, and 4. The written planning documents of these 169 projects, representing urban and local areas of all city sizes, were used to assess – through text mining and text analysis – the innovation performance measures. To prevent the likelihood of common method bias, the organizations of all 169 project teams were invited to participate in a survey on stakeholder management, and on IT and project management tool use. In total, 107 urban innovation project teams from different regional ecosystems, including 136 organizations (1.27 participating organizations per urban innovation project) responded to the invitation. Additionally, a qualitative analysis involving 33 urban innovation projects was undertaken to indicate the urban innovation process and to identify the barriers to and success factors of this process. To ensure an in-depth investigation of the urban innovation projects, a small sample size was used. Therefore, 20 semi-structured interviews were conducted at two points in time with experts from seven urban innovation projects (again multiple experts per initiative; interviews lasted between 30 and 60 minutes). The data sample included projects from urban and local areas in the north of Germany. Furthermore, to extend the sample size, structured short telephone interviews (lasting about 15 minutes) were conducted with an additional 26 urban innovation project teams. In these interviews, the project teams provided information on whether they implemented the innovation alternatives they had previously developed, and on the innovation drivers identified through the semi-structured interviews in the seven urban innovation projects. In addition, the qualitative results relied on information obtained from

the urban innovation projects' planning documents to determine their scope, and from the projects' homepage and newspaper articles to validate the experts' information on, for example, the implementation success of the projects.

Several research methods and two levels of analysis are used to answer the four research questions. On the firm level, the results rely on a partial least squares (PLS) regression analysis from multi-informant survey data (e.g., Chin, 1998; Chin et al., 1999; Chin et al., 2003). On the ecosystem level, a qualitative content analysis (Gioia and Chittipeddi, 1991; Gioia et al., 2012) and a fuzzy-set qualitative comparative analysis (fsQCA) (Fiss, 2007; Ragin, 2008; Rihoux and Ragin, 2009) provides in-depth insights in urban innovation processes and dependencies. Further, text mining (Meyer et al., 2008; Pang and Lee, 2008; Uotila et al., 2009) and text analysis (Antons et al., 2018; Schultz et al., 2012) are used to produce the urban innovation implementation related performance measures and the degree of innovativeness. The combination of text-based data with survey data in linear regression analysis reduces the common-method caused by data obtained from a single source.

#### 4 Summary of the research articles

The four papers in this dissertation are forthwith briefly described. Table 3 provides a detailed overview of the methods, data samples, theoretical perspectives, research questions, results, and implications of the scientific articles.

*Paper 1:* The first paper of this dissertation, entitled ‘*Use and efficacy of information technology in innovation processes: The specific role of servitization*’, focuses on a firm’s ability to use IT as an information processing capability and the influence of a firm’s degree of servitization on this capability. In the context of information processing (Galbraith, 1974; Daft and Lengel, 1986), previous research emphasized the specific role of IT, which is the focus of this study. Innovation activities and, particularly, service innovations impose high demands on a firm’s information processing capabilities because of their high complexity and intangibility (e.g., Carbonell et al., 2009), also considering that support in the form of collaboration, coordination, and communication through IT is becoming increasingly important for innovation (Saldanha et al., 2017). However, to date, research does not fully understand the underlying mechanisms through which IT improves the firm’s innovation performance. Furthermore, it ignored the firm’s business focus as a contingency factor that can complicate information processing.

By using a cross-industry, multi-informant sample of the innovation programs of 116 firms, this article provides empirical evidence that intensive IT use, in order to exchange information with internal and external stakeholders, improves firm-wide market knowledge, which in turn has a positive impact on a firm’s innovation program performance. The performance impact of market knowledge becomes stronger with increasing degrees of servitization, thereby emphasizing that the development of new services heavily depends on the knowledge about customers and other stakeholders. Additionally, this research demonstrates the dilemma that servitized firms face: Their business focus hinders the use of IT tools, although the latter will enable them to gain more benefits from the improved market knowledge they create. The empirical results underline that a higher degree of servitization reduces the use intensity of IT.

The paper identifies the specific information processing barriers organizations face when they develop service innovations. However, urban innovations exceed service innovations’ complexity and, so far, the underlying mechanisms in these complex

innovations remain unclear, also considering that both qualitative and quantitative research are missing. Paper 2, 3, and 4 thus focus on urban innovations.

*Paper 2:* The second paper of this dissertation, entitled ‘*Sustain(able) urban (eco)systems: Stakeholder-related success factors in urban innovation projects*’, qualitatively addresses the underlying mechanisms of innovation processes in the complex and adaptive urban ecosystem. The complex adaptive systems (CAS) perspective (Anderson, 1999; Anderson et al., 2012) allows an exploratory analysis of the complex stakeholder interactions and urban innovation processes as means to achieve urban transformation in urban ecosystems. In the sense of innovative urban restructuring of, for example, stakeholder alliances, industrial sites, and urban districts, urban innovations may face specific innovation barriers and recognizing these barriers could prevent innovation resistance (e.g., Mieg, 2012). Consequently, implementing urban innovations depends on innovation drivers, because these innovations can fail if stakeholders reject them, due to their implementation greatly depending on the stakeholders’ willingness to adopt them.

Based on a qualitative content analysis and a qualitative comparative analysis (QCA) with data from 33 German urban innovation projects, the paper shows that urban innovation implementation necessarily relies on detailed feasibility checks of the developed innovation alternatives and transparent and comprehensible stakeholder communication in the development and implementation process. Thereby, the in-depth analysis of seven urban innovation projects based on a qualitative content analysis of 20 semi-structured interviews at two points in time reveals a three-phase urban innovation process and numerous innovation barriers and drivers. The fsQCA emphasizes configurations of innovation drivers that result in successful innovation implementation, and delivers a toolbox to successfully implement urban innovations by means of different innovation drivers. For example, the presence of stakeholder incentives, strong implementation partners, and transparent and comprehensive communication can still result in implementation. This suggests that not all previously identified drivers are relevant success factors and confirms the complexity and adaptivity of urban innovations.

Although paper 2 emphasizes the reliance of urban innovation on stakeholder acceptance and involvement, the qualitative results only indicate that the concrete influence and quantitative validation of these results are necessary. Paper 3 and 4 thus focus on the causal dependency of stakeholder involvement on urban innovation success, and thereby

emphasize stakeholder management capabilities in the form of digital tool and formal management use.

*Paper 3:* The third paper of this dissertation, entitled '*The more the better? The role of stakeholder involvement and digital tools in urban innovation projects*', addresses the possible negative consequences of a large number of stakeholders and digital tools for internal and external information processing on the implementation orientation of urban innovation projects. Urban innovation development requires the flexible and well-organized involvement of heterogeneous stakeholders (e.g., Caragliu et al., 2016; Planko et al., 2017). However, because of anticipated coordination problems, the integration of all relevant stakeholder groups can exceed the project teams' information processing capabilities, increase the project complexity, and hamper urban innovation (Galbraith, 1974; Patanakul et al., 2012; Lindkvist et al., 2019). These challenges can decrease the ability of urban innovation projects to implement the intended innovative solutions. Current research does not clarify the conflict between the required involvement of stakeholders to develop effective innovation, and the limited implementation efficiency brought about by high levels of complexity and coordination costs while collaborating with a heterogeneous group of stakeholders. Therefore, this paper analyzes how stakeholder involvement breadth (i.e., the number of relevant stakeholder groups) and stakeholder involvement depth (i.e., the collaboration intensity with external stakeholders during the early innovation phase) influence the implementation orientation of innovation projects, and how internal and external information processing tools facilitate stakeholder involvement.

The results rely on a text mining analysis of 169 planning documents to assess the implementation orientation of targeted innovations and survey data of 106 urban innovation projects to measure the independent variables. The results provide empirical evidence that broad stakeholder involvement affects urban innovations' implementation negatively, but that the deep involvement of stakeholders has the opposite effect. Moreover, the intensive use of digital involvement tools hampers broad stakeholder involvement and supports intensive stakeholder involvement, while a high degree of IT supported project formalization weakens the positive effect of stakeholder involvement intensity on the implementation orientation.

The results of this paper suggest that stakeholder prioritization is necessary in urban innovation projects. However, stakeholders can be distinguished according to their salience, their urgency, and their overall implementation influence in urban innovation projects (e.g., Mitchell et al., 1997). In urban innovation the attitude of stakeholders toward the innovation object is of special interest, because practice shows that larger infrastructural projects in particular face resistance and that existing research has not investigated this on a quantitative basis. Therefore, this dissertation concludes with an in-depth investigation of the consequences of skeptical stakeholder involvement on innovativeness and implementation and identifies the capabilities that enables a project team to involve skeptical stakeholders.

*Paper 4:* The fourth and last article of the dissertation, entitled '*Cooperating with the opposition: The influence of skeptical stakeholder involvement on urban innovation projects' innovativeness and implementation*', focuses on the impact of stakeholders who have a negative opinion of an innovation project. They may change the scope of the projects, delay, and even entirely block projects so that innovation alternatives do not reach full implementation. On the contrary, innovation projects may also benefit from skeptical stakeholder's contributions due to their diverse knowledge and perspectives (e.g., Grimpe et al., 2019). Urban innovation projects are suitable to explore these relationships, because they target the development and implementation of innovations like collectively used infrastructures and resources in a city neighborhood. Smart city solutions and innovative district heating grids – as examples of these innovations – face substantial opposition from skeptical and simultaneously powerful private and public stakeholders.

Based on an analysis of 169 planning documents and survey data from 107 urban innovation projects, the results provide empirical evidence that skeptical stakeholders are the only group whose involvement positively influences the project's innovativeness and its implementation orientation, while their involvement does not influence the current implementation status. The attitude of stakeholders is thus a relevant criterion in urban innovation stakeholder prioritization. The results also show that skeptical stakeholder involvement requires resources and moderate degrees of formal management, because both increase the intensity of skeptical stakeholder involvement. Thereby, the results indicate that teamwork quality does not influence skeptical stakeholder involvement, which is contrary to the published findings of previous research.

**Table 3 Overview of papers, methods, samples, results, and implications**

	<b>Paper 1</b>	<b>Paper 2</b>	<b>Paper 3</b>	<b>Paper 4</b>
<b>Method</b>	Survey data with multiple respondents; PLS regression	Qualitative data with semi-structured in-depth and structured short interviews; Qualitative content analysis and fsQCA	Text mining data and survey data with multiple respondents; Linear regression	Text mining data, secondary text-based and online research-based data and survey data with multiple respondents; Linear regression
<b>Data sample</b>	887 respondents from 116 firms	20 in-depth interviews at two points in time with experts from seven urban innovation projects; 26 short interviews with experts from 26 urban innovation projects	169 planning documents from urban innovation projects; 135 respondents from 106 urban innovation projects	169 planning documents from urban innovation projects; 136 respondents from 107 urban innovation projects
<b>Theoretical perspective</b>	Organizational information processing (Galbraith, 1974; Tushman and Nadler, 1978)	CAS theory (Anderson, 1999)	Instrumental stakeholder theory (Donaldson and Preston, 1995); Organizational information processing (Galbraith, 1974; Tushman and Nadler, 1978)	Skeptical stakeholders in innovation, project, and stakeholder management literature (Markham et al., 1991; Hauschildt, 1999); Stakeholder theory (Freeman, 2010)
<b>Research question</b>	How does IT as an information processing capability for internal and external stakeholder involvement influence a firm's innovation program performance? What role does a firm's degree of servitization play?	How is innovation development in complex adaptive urban systems designed? Which specific barriers does urban innovation implementation face? Which success factors remove barriers and support the implementation of urban innovations?	How do stakeholder involvement breadth and stakeholder involvement depth influence urban innovation's implementation orientation? Which information processing mechanisms influence the efficiency and efficacy of stakeholder involvement in urban innovation?	How does skeptical stakeholder involvement influence urban innovation projects' innovativeness and implementation orientation, and status? How can a project team facilitate skeptical stakeholder involvement?
<b>Result overview</b>	Positive effect of IT for internal stakeholder involvement and IT for external stakeholder involvement on innovation program performance, fully-mediated by market knowledge; Negative effect of servitization degree on IT use, although high market knowledge is necessary for service development	Three-phase urban innovation process: <ul style="list-style-type: none"> <li>- Information and empowerment</li> <li>- Stakeholder collaboration and detail planning</li> <li>- Implementation</li> </ul> Toolbox with nine configurations of innovation drivers that result in implementation success	Negative effect of stakeholder breadth and positive effect of stakeholder depth on the implementation orientation; Number of digital stakeholder involvement tools are negative for stakeholder breadth, but positive for stakeholder depth, while high degrees of IT-based formalization are negative for deep stakeholder involvement	Positive effect of skeptical stakeholder involvement on innovativeness and implementation orientation; Resource availability encourages skeptical stakeholder involvement; formal management has an inverted u-shaped effect on skeptical stakeholder involvement
<b>Implications</b>	IT increases a firm's market knowledge and thus has an indirect and positive influence on innovation performance; innovation complexity hampers IT use for stakeholder involvement, although it increases a firm's information processing capabilities	Urban innovation is a highly complex innovation process that relies on flexible and adaptive stakeholder collaboration in specific urban ecosystems; established stakeholder and innovation management approaches must be customized to urban requirements	Stakeholder prioritization necessary to decrease complexity, because a large number of stakeholders and a large number of tools exceed a project team's information processing capabilities	Stakeholder attitude is a relevant criterion for stakeholder prioritization, because skeptical stakeholders are a valuable but under-estimated resource that fosters innovativeness and implementation in complex innovation processes



## 5 Discussion

The dissertation shows that the application of established stakeholder management theories and innovation management approaches is only partly applicable to complex innovation processes. The overall results not only suggest that stakeholder involvement is a mean to cope with complexity in innovation processes, but also that it is a double-edged sword in terms of broad stakeholder involvement. The following section discusses the overall results based on the conceptual framework depicted in Figure 2.

The results underline that well-chosen stakeholder involvement helps to achieve innovative solutions and their implementation. Both innovative solutions and their implementation are performance measures in urban innovation where it is difficult to measure financial impact because of the urban ecosystem's fuzziness and funding guidelines not specifying performance indices, except for carbon emission savings and energy efficiency increases (e.g., Kastalli and Neely, 2013). In accordance with previous literature, innovativeness can only be quantified through a multidimensional construct (Nam and Pardo, 2011; Nilssen, 2019). Paper 4 discloses the degree of innovativeness as the inverted diffusion rate of innovation alternatives in six innovation fields that focus on different innovation dimensions, including technological innovations (e.g., renewable energy use), organizational innovations (e.g., energy efficient energy use), and behavioral innovations (e.g., climate-friendly consumer behavior) (e.g., Schultz et al., 2012; Schultz et al., 2013). The qualitative results of paper 2 emphasize the need for a multidimensional innovativeness construct, also considering that several experts were of the opinion that technological innovativeness may not necessarily be the overarching goal of sustainable urban transformation and that the combination of established technologies in new organizational forms could provide a more promising solution to future ecological needs. For example, many district heating systems do not rely on innovative technologies, but their implementation and operation through non-profit operating companies is an innovative way of organizing these systems. Nevertheless, high overall degrees of innovativeness hold the most promise to manage the transition of cities (e.g., Joss, 2015). Papers 2, 3, and 4 measure the key determinants of success factors in innovation development and the implementation of urban innovations during different implementation stages. Whereas papers 2 and 4 measure the actual implementation, paper 3 identifies the implementation orientation in the written planning documents based on a text mining analysis. Not only do all these measures account for the actual implementation success, but

the positive influence of stakeholder involvement on these implementation measures also validates the developed scales. The results of paper 1 indicate that stakeholder management capabilities become more important for complex innovations, because the degree of servitization increases the positive influence of market knowledge on the performance of the innovation program. The results of papers 2, 3, and 4 suggest that organizations should develop ecosystem innovations and indicate how organizations can benefit from these developments. Irrespective, future research is necessary to investigate the influence of an organization's ecosystem innovation activities on innovation program performance.

The results show that information processing capabilities only indirectly contribute to the success of complex innovations. This conclusion is consistent with information processing theory (Galbraith, 1974; Tushman and Nadler, 1978) which states that information processing capabilities, by building internal and external capabilities, decrease environmental uncertainty. The results of paper 1 indicate that information processing increases an organization's market knowledge, and only indirectly the innovation program performance, because information processing has no direct and significant effect on the performance. The results of paper 3 confirm that external information processing capabilities (digital tools for stakeholder involvement) increase stakeholder information gathering and processing, which in turn correlates positively with implementation orientation. Nevertheless, information processing capabilities can be a double-edged sword. IT-based formal management tools that provide internal information processing capabilities positively influence implementation orientation but hamper the absorption of stakeholders' contributions. Organizations that engage in complex innovations need to establish information processing capabilities, and mainly use them to build up knowledge capabilities. As the literature suggests, these knowledge capabilities ensure long-term knowledge transfer and ongoing strategizing (Dougherty and Dunne, 2011), as developing complex innovations require flexibility and adaptability.

The results emphasize the challenges of stakeholder coordination that must be dealt with to decrease complexity. Paper 2 shows that the urban innovation process requires formal structures. Clear responsibilities and milestones in the development process enable a project team to establish contact points, provide stakeholder incentives, and deal with stakeholder irresponsiveness. Additionally, in the process formal structures support transparent and comprehensible stakeholder communication, and ease detailed feasibility checks which form the basis of successful implementation. These results accord with

previous research (Widén et al., 2013; Schultz et al., 2019a). Nevertheless, the quantitative investigation in paper 4 shows that too high levels of formalization may have negative effects on stakeholder involvement and could, as a result, hamper the absorption of stakeholders' contributions. Complex innovations require moderate degrees of stakeholder coordination. Stakeholder prioritization therefore becomes more important in order to cope with the complexity inherent in these innovations. Paper 4 highlights the influence of stakeholders' attitude as a prioritization criterion. Skeptical stakeholder involvement, in particular, fosters urban innovation success and, subsequently, a constructive opposition. The negative influence of skeptical stakeholders is not valid in urban innovation. Furthermore, the involvement of skeptical opinion leaders like advocacy groups has a signaling effect on other stakeholder groups, as this confirms the importance of the project, thereby increasing overall stakeholder acceptance and engagement (Wang et al., 2014; Fliaster and Kolloch, 2017).

## **6 Implications and limitations**

The following section summarizes the overall results of the PhD thesis and provides an overview of the study's limitations and its theoretical and managerial implications.

### **6.1 Summary**

Complex innovations like service and urban innovations have high information requirements and organizations gather and process information from ecosystem stakeholders by using IT as a structural mechanism to ensure information processing. Although intensive IT use positively influences the performance of complex innovations, organizations experience problems when establishing IT infrastructures and instituting the use of digital tools for internal and external stakeholder involvement. Inappropriate IT tools and too many different digital tools, like web-based toolkits and crowdsourcing, can hamper the success of complex innovations as a result of the increased coordination efforts this requires. Organizations and project teams need to install a flexible, modular, and open IT system for efficient IT use, and ensure that all relevant internal and external stakeholders are included.

Complex innovations like urban innovations have complex innovation processes that rely on flexible and adaptive stakeholder collaboration. However, established stakeholder and innovation management approaches are only partly applicable to this context. First, stakeholder information and empowerment unfreeze stakeholders. Second, collaboration during the detailed planning moves the stakeholders toward sustainability. Third and finally, innovation implementation leads to urban transformation. As a result, several barriers could hamper implementation, although transparency and comprehensibility in innovation development and feasibility checks during the collaboration phase are prerequisites of and encourage urban innovation implementation. The results furthermore reveal a toolbox with enough configurations to ensure implementation.

Urban innovations' innovativeness and their implementation profit from stakeholder involvement but only if the involved stakeholders are well-chosen, because too broad stakeholder involvement may have the opposite effect. In respect of intensive stakeholder involvement, digital tools encourage stakeholder information gathering and processing, but increase coordination efforts and thus complexity. However, the attitude of stakeholders is only one criterion to differentiate between stakeholders. Skeptical stakeholder involvement increases the degree of innovativeness and implementation, thereby enhancing constructive

opposition. Moderate levels of formal management support stakeholder involvement, but extreme formalization hampers the development of an absorptive capacity.

## **6.2 Theoretical implications**

This dissertation contributes to stakeholder and innovation management literature and extends the current understanding of complex innovations, thereby identifying the firm's specific business focus as a key contingency factor and explaining and establishing urban innovations as a stand-alone innovation type. Therefore, it responds and contributes to the current call for research on the management of complex innovation (e.g., Dougherty, 2017).

Further, the PhD thesis addresses the management of innovations for major global challenges. Sustainability demands complex innovation, because these sustainable and eco-innovations require the collaboration of government institutions, industry, and private individuals (e.g., Karakaya et al., 2014). Therefore, this study responds and contributes to the call for research on the required transformation of complex systems to counter climate change (e.g., Levy and Liechtenstein, 2012; Geels et al., 2017). As suggested by the Sustainable Development Goals of the United Nations, there is a need for urban innovations to develop sustainable cities and communities. This thesis extends existing research on urban innovation management, which was mainly published in public governance and urban planning literature, despite the high practical relevance of the research on urban innovation from an innovation management perspective. This dissertation thus responds and contributes to the call for research on the mechanisms which underlie these complex innovation processes and how to achieve urban transformation (e.g., Da Silva et al., 2019).

Consequently, managing complex innovation always means taking different stakeholders' needs into account. This research expands current literature dealing with the downsides of stakeholder involvement (e.g., Garcia-Castro and Francoeur, 2016) and shows stakeholder involvement as a double-edged sword: While intensively involving a few stakeholder groups yields positive performance effects, broad stakeholder involvement decreases innovation performance. Based on instrumental stakeholder theory (Donaldson and Preston, 1995; Jones et al., 2018), this dissertation introduces the stakeholder management capabilities of information processing and coordination as means to benefit from stakeholder involvement in urban innovation project performance. In this respect, the

dissertation expands information processing theory (Galbraith, 1974; Tushman and Nadler, 1978) by showing that internal and external information processing activities lead to decreased environmental uncertainty in complex innovation processes, which in turn makes their success more likely. Digital tools that gather and distribute stakeholder information internally and externally, and IT-based formal management tools that structure and process the information in the project team, shape this stakeholder information processing capability, thereby leading to increased market and ecosystem knowledge on organization and ecosystem level. The combination of both theoretical frameworks delineates the boundaries of stakeholder information processing and indicates how to overcome information processing obstacles by using digital tools. Further, the dissertation takes the increasing importance of digitalization into account and contributes to research on the use and efficacy of digital tools.

Furthermore, the dissertation transferred the concept of stakeholders' attitude in project management (e.g., Winch and Bonke, 2002) to complex innovation management. The results contribute to the call for additional relevant stakeholder characteristics (e.g., Fliaster and Kolloch, 2017) and show that skeptical stakeholders are not only a cause of innovation resistance, but a valuable source of innovation development and implementation in the urban ecosystem, thereby extending research on innovation champions and antagonists (e.g., Markham, 2000).

Additionally, the dissertation extends current research by providing several optimized variable measures. First, paper 1 responds to the call for an improved measurement of firms' service focus (e.g., Hipp and Grupp, 2005) by providing a fine-grained measurement for the degree of servitization. Unlike previous studies that distinguish between service and manufacturing firms in terms of industry codes and sector classifications, this study focuses on how relevant specific services are for the firm, thereby capturing the entire continuum of relevant service types. The study also considers the blurred boundaries between product and service businesses by assessing the firm's business focus (Vargo and Lusch, 2004). Second, paper 3 introduces a more fine-grained measure to account for the implementation orientation, which is extracted from concrete urban innovation planning documents. Implementation orientation is measured based on text mining, following a sentiment analysis, and the study provides proof of the applicability of text-based measures in empirical studies and innovation management research (Meyer et al., 2008; Uotila et al., 2009). Third, paper 3 and 4 deliver a more fine-grained measurement for stakeholder

involvement intensity; a measurement that accounts for stakeholder involvement intensity in the three phases at the front end of innovation and dependent on stakeholders' position toward the project and their influence on the project implementation. Fourth and finally, paper 4 introduces an innovativeness measurement using an analysis of the composition of the innovation portfolio based on project documents. This measurement is independent from the subjective evaluation of a project's innovativeness by, for example, the project team. As such, the paper emphasizes that innovativeness relies on multidimensional constructs (Schultz et al., 2013), especially in urban innovation (Dente and Coletti, 2011; Nilssen, 2019). The combination of survey and text mining data in two of the four papers prevents common-method bias and identifies new ways to externally validate the results.

### **6.3 Limitations**

Despite its contributions, this dissertation has certain limitations that must be considered. The PhD thesis builds on two types of complex innovations: Service innovation and urban innovation. Stakeholders are important in both innovation types. Urban innovations rely on their implementation in a specific urban environment and thus, multinational stakeholders play a minor part. Nevertheless, the results may require validation in other complex sector-specific innovations like drug development and renewable energy development (e.g., Dougherty and Dunne, 2012), where multinational stakeholders need to be involved and innovation development relies on collaboration beyond local and national ecosystems, namely in business ecosystems. Furthermore, innovations' complexity in the investigated processes may increase because of the increasing relevance of digital innovations that have higher levels of complexity and that differ substantially from analog innovations (Yoo et al., 2012). Although this dissertation took digital tools into account to address increasing digitalization, additional influences cannot be excluded.

Furthermore, the PhD thesis contains an in-depth investigation of the urban ecosystem. The focus is on the ecosystem management from a project team perspective. Future research should investigate organizations that implement these complex innovations and uncover organizational capabilities which result in successful urban innovation implementation. For example, paper 4 produced valuable insights on skeptical stakeholder management. Nevertheless, the processes that result in stakeholder skepticism or that

overcome skepticism remain unclear. Therefore, an explorative, in-depth analysis of urban innovation projects and all stakeholders is necessary to reveal why organizational and individual stakeholders are skeptical. Further, this research does not indicate the proportional contribution of complex innovations like urban innovation to the program performance of an organization. A sustainable increase in their program performance may incentivize organizations to participate in these innovation processes. Additionally, it would be interesting to see how urban innovation implementation evolves over time. Although the dissertation accounts for the actual implementation status, the implementation of urban innovations is incomplete, also considering the long time horizon of some the innovation alternatives' implementation.

This PhD thesis does not show how information processing capabilities influence the degree of innovativeness. The results of paper 4 confirm that skeptical stakeholder involvement positively influences the degree of innovativeness, and the results of paper 3 reveal that external information processing eases stakeholder involvement and promotes the gathering of stakeholders' contributions, but the direct effect of information processing capabilities on innovativeness has not been investigated. Although the models contain several covariates, additional covariates may be required to explain more of the predicted variables' variance. Additional moderating and mediating variables can be included in the models. The dissertation's measures have been developed and validated with care, nevertheless, they may require further validation. Finally, the dissertation includes German and Austrian firms (paper 1) and German urban innovation projects (paper 2, 3, and 4). Future research can extend the sample size and include urban innovation projects not implemented in but also beyond Germany.

#### **6.4 Managerial implications**

Based on the proposed and empirically tested models, it is possible to derive several recommendations for complex innovation management. Innovations are often developed in projects. The main research object of this dissertation, urban innovation projects, delivers valuable insights on the project and public management of these public-private partnerships.

First, managers who aim at higher innovation program performance ought to prioritize the gathering, processing, and distribution of stakeholder information, regardless of their



organization's business focus. Investments in IT tool installations that help employees and project members collect information from and interact with external stakeholders in their ecosystem, as well as IT tools that facilitate the internal information and knowledge exchange between the organization's and project team's members, will not only contribute to better market and ecosystem knowledge, but will also result in more successful innovation activities. Complex innovations rely on tacit knowledge and involve multiple stakeholders. This makes information processing more challenging. On the one hand, organizations that place more emphasis on services, tend to use IT tools less intensively. On the other hand, project teams that deal with many stakeholders only need to focus on a few digital tools in order not to exceed their coordination capabilities. Furthermore, although IT tools that facilitate formal management in urban innovation project teams strengthen the implementation focus, they may hamper the team's absorptive capacity. In complex innovation processes, managers need to carefully choose and use IT tools for internal and external information processing that have the best fit with the organizations' and the stakeholder IT infrastructures.

Additionally, this research delivers a toolbox for urban innovation managers that provides configurations of different innovation drivers, which support implementation success while dependent on the urban ecosystem's structure. The results suggest that organizations should not simply transfer processes and knowledge from established innovation management without considering the innovation's complexity. Managers should always conduct a detailed stakeholder analysis based on predefined criteria to identify those stakeholders who have the most ecosystem knowledge and who can increase the project team's knowledge base. In urban innovation projects, managers should pay special attention to skeptical stakeholders and distinguish the stakeholder groups based on their position on the project, as the results show that skeptical stakeholders have a positive influence on innovation performance. Key stakeholders can come from real estate and housing companies, private homeowners, and implementation partners like energy utilities.

The data propose a three-step urban innovation process: First, managers should assess the urban area's structure, including the key and existing stakeholders' networks, as well as their individual goals to attain stakeholder empowerment. Second, managers need to arrange events that merge the stakeholders' individual goals and assess stakeholder networks, by, for example, arranging events like regular meetings, discussion rounds, and workshops. These events are necessary to motivate the stakeholders to collaborate and

engage in detail planning for urban transformation and may require innovative communication and integration channels, for example by combining energy efficiency increase topics with circus entertainment. This will ensure transparency and comprehensibility in the development process and additionally ‘unfreeze’ stakeholders. Providing material and non-material incentives, like financial grants and supporting applications for public funding, further motivates stakeholders. Third, managers should guide the implementation of urban innovation alternatives through clear structures and formal management to reach the sustainable urban transformation.

Additionally, managers should use digital involvement tools, including crowdsourcing and social media, to interact with their key stakeholders during the three-step process. The comprehensive use of digital involvement tools eases flexible and agile stakeholder information gathering in case of intensive (key) stakeholder involvement, thereby positively influencing the strength of the implementation orientation. Managers should also regulate the use of formal management methods and tools, and should keep the level of formalization for stakeholder involvement at a moderate level in order to ensure flexible and agile stakeholder interaction and to sustain the ability to process the information they receive from the stakeholders. A rich resource base, namely enough knowledge and planning instruments, facilitates the building of a skeptical stakeholder involvement capability.

The management implications were transferred to five management publications. Table 4 provides an overview of these publications. Article I, II, III, and IV are included in the dissertation’s Appendix. The booklet contains a 60 pages study on the innovation management of energy suppliers, as a type of organization that develops urban innovations.



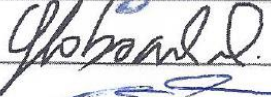






**Table 4. Overview of management articles**

Article	Title	Publication Status	Author(s)
<b>Booklet</b>	Innovationen in der Energiewirtschaft sind machbar! – Innovationsmanagement als Erfolgsfaktor von Energieversorgern	ISBN 978-3-00-056665-3	Schultz, C. Kroh, J. Luetjen, H.
<b>Article I</b>	Innovationskompetenz von Energieversorgern noch auf geringem Niveau	Published 2017 in 'Energiewirtschaftliche Tagesfragen', 67(8), 40-43.	Kroh, J., Luetjen, H., Schultz, C.
<b>Article II</b>	Produkt-Service-Systeme als Chance. Eine Analyse von Servitization-Prozessen bei Energieversorgern	Published 2017 in 'Zeitschrift Führung + Organisation', 86(6), 366-372.	Schultz, C. Luetjen, H. Kroh, J.
<b>Article III</b>	Energetische Quartierssanierung: Energieversorger nutzen Potenziale für branchenübergreifende Innovationsprozesse zu wenig	Published 2018 in 'Energiewirtschaftliche Tagesfragen', 68(10), 66-69.	Kroh, J. Schultz, C.
<b>Article IV</b>	Studie der Uni Kiel: Wann sind Quartiere innovativ?	Published 2018 in 'Emw Energie. Markt. Wirtschaft', 6, 16-19.	Kroh, J. Schultz, C.

## 7 Note on co-authorship

The first, third, and fourth paper presented in this dissertation were respectively co-authored. The lead author is always the first author named. The lead author mainly contributed to idea generation, concept development, and theory, as well as to data generation and method development and analysis. Her contribution also includes result evaluation, interpretation, and writing and revision of the documents. Paper 1 was part of another cumulative PhD thesis (Heiner Luetjen, '*Essays on the Management of Servitization*', Kiel 2018). Table 5 provides an overview of the contributions of the coauthors to the papers in this dissertation.

Table 5. Contribution of co-authors

Paper	Title	Author(s)	Contribution based on DFG 'Sicherung guter wissenschaftlicher Praxis' <sup>1</sup>	Signature
Paper 1	Use and efficacy of information technology in innovation processes: The specific role of servitization	Kroh, J.	Idea generation; concept and theory development; data collection; result evaluation; writing and revision of the manuscript	
		Luetjen, H.	Idea generation; concept and theory development; data collection; result evaluation; writing and revision of the manuscript	
		Globocnik, D.	Data analysis; concept, theory, and method development; revision of the manuscript	
		Schultz, C.	Idea generation; concept, theory, and method development; revision of the manuscript	
Paper 2	Sustain(able) urban (eco)systems: Stakeholder-related success factors in urban innovation projects	Kroh, J.	Idea generation; concept, theory, and method development, data collection and analysis; result evaluation; writing and revision of the manuscript	
Paper 3	The more the better? The role of stakeholder involvement and digital tools in urban innovation projects	Kroh, J.	Idea generation; concept, theory, and method development; data collection and analysis; result evaluation; writing and revision of the manuscript	
		Schultz, C.	Idea generation; concept; theory, and method development; revision of the manuscript	
Paper 4	Cooperating with the opposition: The influence of skeptical stakeholder involvement on urban innovation projects' innovativeness and implementation	Kroh, J.	Idea generation; concept, theory, and method development; data collection and analysis; result evaluation; writing and revision of the manuscript	
		Schultz, C.	Idea generation, concept; theory, and method development; result evaluation; revision of the manuscript	

<sup>1</sup> [http://www.dfg.de/download/pdf/dfg\\_im\\_profil/reden\\_stellungnahmen/download/empfehlung\\_wiss\\_praxis\\_1310.pdf](http://www.dfg.de/download/pdf/dfg_im_profil/reden_stellungnahmen/download/empfehlung_wiss_praxis_1310.pdf) (Stand 27.8.2013), insbesondere Empfehlung 11 und zugehörige Erläuterung auf S. 29-31

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**Paper 1: Use and efficacy of information technology in innovation processes: The specific role of servitization**

Julia Kroh; Heiner Luetjen; Dietfried Globocnik; Carsten Schultz

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**Abstract**

Innovation activities and, particularly, service innovations impose high demands on a firm's information processing capabilities. IT tools are supposed to support internal and external information flows, thereby improving a firm's information processing capabilities. However, past research is indecisive about how IT tools influence innovation performance. Furthermore, past research has not considered that services have an increasingly relevant role in a firm's innovation portfolio that can complicate information processing. This study therefore draws on information processing theory and service innovation literature to develop a conceptual model that explains how IT use intensity—depending on the firm's business focus—affects innovation program performance. By using a cross-industry, multi-informant sample of the innovation programs of 116 firms, which were collected from 887 informants, this article provides empirical evidence that (i) intensive IT use in order to exchange information with internal and external stakeholders improves the firm-wide market knowledge, which in turn has a positive impact on a firm's innovation program performance; (ii) the performance impact of market knowledge becomes stronger with increasing degrees of servitization; (iii) a higher degree of servitization reduces IT's use intensity. This research demonstrates the dilemma that servitized firms face: Their business focus hinders the use of IT tools, although the latter will enable them to gain more benefits from the improved market knowledge they create.

Keywords: information processing; information technology; innovation performance; IT tools; IT use intensity; market knowledge; servitization; service innovation

## **Introduction**

Information processing is a key activity in innovation, because it reduces environmental uncertainty (Galbraith, 1974) and supports firm-wide information distribution (Daft and Lengel, 1986). In this context, previous research emphasized the specific role of information technology (IT), which is the focus of this study. IT tools increase a firm's information processing capability by expanding the amount of information that the organization can manage (Ben-Arieh and Pollatscheck, 2002). Support in the form of collaboration, coordination, and communication through IT is becoming increasingly important for innovation (Peng et al., 2014; Kawakami et al., 2015; Saldanha et al., 2017). For example, web-based innovation platforms, innovation process management software, and social media facilitate information flows within and beyond the firm's boundaries (Marion et al., 2014; Moe and Schweidel, 2017). However, to date, research does not fully understand the underlying mechanisms through which IT improves the firm's innovation performance. Furthermore, it has not considered the firm's business focus as a contingency factor that can complicate information processing. In this respect, the share of services in the firm's entire business portfolio, that is the degree of servitization, plays an important role (Neely, 2008). This study aims at developing and testing a conceptual model, which investigates (i) how IT affects innovation program performance and (ii) the role of the firm's business focus through the theoretical lenses of organizational information processing theory (Galbraith, 1974; Tushman and Nadler, 1978) and service innovation (Johne and Storey, 1998; Fitzsimmons and Fitzsimmons, 2008).

Previous studies, which investigated the performance relevance of IT, could not find that IT had a direct or a generally valid positive effect on innovation performance. On the contrary, empirical evidence is more inclined to show that the effect is mediated through IT use frequency (Barczak et al., 2007; Marion et al., 2014; Mauerhoefer et al., 2017), that it is dependent on the innovation development phase (Durmuşoğlu and Barczak, 2011; Marion et al., 2014), and that it is also dependent on organizational complementary assets, such as strategy and culture (e.g., Kawakami et al., 2015). These findings indicate that intermediate outcomes must be considered to better understand how IT tools affect innovation processes. Due to the fact that most studies analyze the effect of IT at the project level, they do not recognize firm-wide intermediate outcomes, and-even more critical-research currently does not know much about the firm-level impact of IT tools. Since



information processing activities and particularly investments in IT are usually directed at the overall innovation program and not only at specific projects, IT's impact on the overall innovation performance is the relevant criterion for organizational decision makers. Thus, the first research question, which this study addresses, is: *What mechanisms explain how the use of IT tools impacts on firm-level innovation program performance?*

In order to address this question, this article draws on organizational information processing theory (Galbraith, 1974), which emphasizes structural mechanisms to manage information flows and cope with uncertain environments. In this respect, this study introduces market knowledge as the central mediator between the IT use intensity and innovation program performance. In contrast to prior research, this article distinguishes between IT tools that are used to facilitate internal and external information flows. Hence, this study aims to show how IT tools can impact on innovation processes at the firm level.

Service innovation literature also shows that market knowledge is particularly important to cope with the high complexity and intangibility inherent in service innovation (Ordanini and Parasuraman, 2011; Storey and Larbig, 2018). The deep involvement of customers, employees, and service network partners impose significant demands on the organization to generate, process, and distribute information between and together with diverse stakeholders (e.g., Nijssen et al., 2006; Wieland et al., 2012; Storey et al., 2016). Regarding the use of IT tools, previous research has emphasized their importance for service innovations (e.g., Plattfaut et al., 2015), but has also identified several challenges, due to the heterogeneity of the stakeholders (Jaakkola et al., 2017). This implies that the use of IT and its performance impact cannot be independent from the firm's business focus. Prior research has, thus far, not considered this aspect, despite the increasing importance of service innovations and the fact that more and more manufacturing and product-centric firms complement or substitute their product business with services, a trend that is referred to as servitization (e.g., Kowalkowski et al., 2017). Given the specific service innovation requirements of information processing, as well as its increasing economic relevance, the second research question is: *How does the degree of servitization of a firm impact on the use and effectiveness of IT tools?* This study addresses this question by drawing on the service literature and extends the main model by integrating business focus as a contingency factor.

The developed model is tested with a cross-industry, multi-informant sample of innovation programs, which consist of 116 firms that were collected from 887 informants. The subsequent contribution is threefold: First, the results support that—in respect of both internal and external information flows—IT use intensity has a significant positive effect on innovation program performance by improving a firm’s market knowledge. Second, the results show that the degree of servitization strengthens the positive effect that market knowledge has on innovation program performance. However, at the same time, the degree of servitization leads to a lower IT use intensity. Consequently, servitized firms hardly use IT to support their information flows, but benefit more from market knowledge by achieving superior innovation program performance. This finding exposes the current dilemma of servitized firms, namely the gap between the required level of IT support and its current use intensity in practice. Third, this study provides a more fine-grained measurement for the degree of servitization, which goes beyond simplifying the industry code classifications and accounts for the blurred boundaries between the product and service businesses by assessing the firm’s actual business activities.

### **Conceptual framework and hypotheses**

#### **IT as structural mechanism to increase information processing capability for innovations**

Organizational information processing theory states that firms have to develop an information processing capability to enable them to fulfill their information needs and cope with the uncertainty in their environment (Galbraith, 1974). Organizational tasks are split into many subtasks and assigned to different interdependent roles, which requires high internal coordination and information exchange (e.g., Premkumar et al., 2005; Zhou and Benton, 2007). The theory particularly emphasizes structural mechanisms that gather, process, and distribute information throughout the organization to allow it to fulfill its tasks (Tushman and Nadler, 1978; Daft and Lengel, 1986).

Organizational information processing theory fits the context of a firm’s innovation tasks well. Innovation activities require different functional areas within a firm to interact. Furthermore, innovation activities bear risks and are inherently uncertain, especially when the development of products or services differs from a firm’s existing experiences (Carbonell et al., 2009; Schultz et al., 2013). Consequently, innovation activities require

much market knowledge, which means to absorb and act on relevant information about customers' and competitors' needs, activities, and behaviors (De Luca and Atuahene-Gima, 2007). Information processing capabilities enable a firm to gather the required external input and translate it into usable information that improves the knowledge of the market that it and its employees require to deliver superior new products and services (Von Hippel, 1994; Veldhuizen et al., 2006).

The innovation literature has highlighted the role of IT as an enabler, or structural mechanism, to process large amounts of information easily, i.e. to increase a firm's information processing capability by extending the existing information systems' technical level (Bensaou and Venkatraman, 1996; Ben-Arieh and Pollatscheck, 2002). Moreover, IT supports the coordination and knowledge sharing activities within a firm and its ecosystem (Zahay et al., 2011). IT can thus help firms to build a comprehensive and well diffused understanding of customer needs and their competitors' strategies, both of which are highly relevant for their success (Bharadwaj, 2000; Jayachandran et al., 2005). Table 1 gives an overview of empirical studies that investigate IT tool use in product and service innovation.

However, prior research has not investigated the role of IT tools in increasing a firm's overall innovation performance by improving its market knowledge. Several studies support the notion that IT tools improve the general information flows between innovation project members (e.g., Song and Song, 2010, Marion et al., 2014) and increase the innovation process's flexibility (e.g., Durmuşoğlu et al., 2006; Bhatt et al., 2010). Others report that the actual use frequency, instead of the mere existence of IT tools, drives performance (e.g., Marion et al., 2016; Reid et al., 2016). In this respect, clear responsibilities for IT tools and regular employee training promote IT use, which is associated with higher innovation project success (Mauerhoefer et al., 2017). Certain studies dealing with the market-related aspects of IT tools in the innovation process's later stages demonstrate that they facilitate innovations' fit with the initial requirements (Durmuşoğlu and Barczak, 2011) and increase the market performance after market entry (Barczak et al., 2007). Interestingly, most of the mentioned studies investigate the impact of IT tools on project performance, thus failing to explain how IT affects the organizational-level outcomes. This is surprising, because information processing is conceptualized as an organizational capability. The relevance of better market knowledge and reduced uncertainty due to superior information processing capabilities is likely to go beyond individual projects and can be assumed to impact all the strategic and operational decisions

**Table 1. Overview of empirical studies on IT tool use in product / service innovation**

Study focus	Authors	Research question	Outcomes	Role of IT and finding
<b>IT as organizational capability</b>	Durmuşoğlu, et al., 2006	How does IT support influence NPD flexibility and costs?	New product flexibility, NPD costs	Direct influence of IT support in NPD teams on outcomes; better IT support increases NPD flexibility and costs
	Barczak et al., 2007	How do antecedents like the project risk, having an IT champion, and the IT embeddedness influence NPD performance?	New product performance (Speed to market, market performance)	Extent of IT usage (number of different used IT tools) positively mediates the relationship of antecedents and NPD performance
	Song and Song, 2010	How do organizational resources and integration barriers like physical separation, goal incongruity, and cultural differences influence NPD performance?	New product performance (Return on investment, market share)	Communication IT and Decision-aiding IT strengthen the organizational resources and R&D market integration relationship, which is the mediator for NPD performance; IT has a direct positive effect on R&D market integration
	Bhatt et al., 2010	How does IT infrastructure flexibility influence a firm's competitive advantage?	Competitive advantage of the firm	IT infrastructure flexibility and competitive advantage relationship is fully mediated by market orientation
	Durmuşoğlu and Barczak, 2011	How does the use of IT tools influence project outcomes dependent on the NPD phase?	New product innovativeness, New product quality, New product market performance	Different IT tools have different effects in NPD phases
	Marion et al., 2014	How does IT infrastructure influence effective product architecture development and project performance?	Project performance (meeting original project objectives) Modular product architecture	IT infrastructure supports effective modular product architectures and project performance
	Kawakami et al., 2015	How do organizational complementary resources like having an IT champion influence NPD performance?	New product performance in comparison to competitors	IT capability (operationalized by IT tool use frequency and IT tool replacement frequency) positively mediates the relationship of organizational complementary resources and NPD performance
	Reid et al., 2016	How do organizational resources (IT Infrastructure, IT embeddedness, firm focus, competitive intensity) influence performance outcomes?	Performance outcomes (generated concepts / prototypes, team collaboration, management evaluation)	IT capability (operationalized as use frequency of general and collaborative IT tools) positively mediates the organizational resources and performance relationship
	Mauerhoefer et al., 2017	How do firm-level IT capabilities like the IT infrastructure influence NPD performance?	New product performance (project effectiveness and efficiency)	IT tool use frequency and IT leveraging competence positively mediate the relationship of firm-level IT capabilities and NPD performance
<b>IT for NPD collaboration</b>	Peng et al., 2014	How does the use extent of different IT tools influence NPD collaboration?	NPD collaboration (extent and timing with customers or suppliers for new product projects)	Use extent of product design and project management tools have positive effect on NPD collaboration; effect increases with lower product novelty, size and task interdependence
	Marion et al., 2016	How does the use of collaborative IT tools differ in development phases of innovation process?	Project performance (meeting original project objectives, subjective project performance)	Collaborative IT tool use is low, but IT use frequency is positively related to project performance

within a firm. Consequently, this research draws on organizational information processing theory's view and investigates the impact that IT use intensity has on the innovation program performance, thereby facilitating information processing capabilities in the form of market knowledge.

To the best of our knowledge, prior research neglected the differentiation between IT tools directed at external stakeholders (e.g., customers, suppliers) and internal stakeholders (e.g., employees of different departments). This differentiation seems relevant, because, in order for IT tools to manage external information flows, they need to focus on gathering market information (Li and Calantalone, 1998). Conversely, for IT tools to manage internal information flows, they need to focus on processing and distributing information within the firm to where it is needed for decision making (Cooper and Zmud, 1990). Accordingly, this study explicitly distinguishes between IT that facilitates either internal or external information flows in order to tap into the full conceptual domain of organizational information processing capability. Table 2 summarizes relevant IT tools for internal and external information flows in product and service innovation.

**Table 2. IT tools for internal and external information flows**

	Category	IT tool
<b>External information flow</b>	Collaboration tools with customers and to generate competitive intelligence	Blogs/Microblogs Cloud-based file sharing Crowdsourcing for assessing and generating ideas Online forums/Online communities Online needs survey Social media Web-based toolkits Web-platforms
	Information and knowledge management tools	Data mining Shared drives/Project rooms E-Mail Web-Meetings Wikis
<b>Internal information flow</b>	Project and process management tools	Decision support systems for project evaluation File transfer protocols Innovation process management software
	Product/Service development and production planning tools	Concept testing software Idea generation software Product design software Virtual prototyping

Adapted from Durmuşoğlu and Barczak, 2007; Marion et al., 2016; Mauerhoefer et al., 2017

**Influence of IT use intensity on innovation program performance**

IT tools that improve external information flows facilitate the interaction with customers to learn more about their needs, problems, and ideas, which are required to create new products and services (Gordon et al., 2008). Collecting and analyzing data from users' activities in online communities and their operating machine data help a firm better understand their customers' current behaviors, their issues and needs, as well as their opinions about competitors' offerings (e.g., Fueller et al., 2008). Web-based toolkits, through which customers can configure, or design, their own solutions, provide information about customers' specifically desired solutions (e.g., Franke and Piller, 2004). Furthermore, with the help of crowdsourcing platforms, ideas for new products and services can be both collected from customers and prioritized (e.g., Poetz and Schreier, 2012). Together, these IT tools help firms gather in-depth knowledge about the market, which will subsequently lead to better informed decisions regarding which innovation activities to pursue and to the building of a superior portfolio of innovation projects. These well-informed innovation activities subsequently result in higher performance (e.g., Baker and Sinkula, 2007). Drawing on the presented arguments, firms whose IT tools have a higher use intensity, which stimulates external information flows, will have better market knowledge, which has a positive impact on their overall innovation performance.

*Hypothesis 1a: IT use intensity to stimulate external information flows has a positive impact on innovation program performance, mediated by market knowledge.*

IT tools that improve internal information flows allow information required to innovate, such as that on customer needs, technical solution knowledge, and competitive intelligence, to be accessible in a timely manner to all relevant employee groups within the firm. This function of the IT's structural mechanism is especially relevant due to innovation activities' cross-functional nature and the growing number of geographically dispersed R&D departments (Blindenbach-Driessen and Van den Ende, 2014; Chen and Lin, 2016). If innovation activities and the knowledge required for innovation are widely dispersed across several departments, this reduces personal information exchange and increases transaction costs (Boutellier et al., 1998). IT tools for internal information exchange help overcome this information challenge by helping different functional groups and departments share information, knowledge, and ideas on the innovation process. IT enables employees to work in virtual network organizations, where they can access and exchange required information on competitors and customers regardless of their location (Montoya

et al., 2009). In other words, IT helps overcome departmental boundaries (Song and Song, 2010) by improving internal communication and the speed with which information is exchanged. In turn these benefits could facilitate the development of better market knowledge within the firm (Jiménez-Castillo and Sánchez-Pérez, 2013) and thus help firms achieve a better overall innovation performance.

*Hypothesis 1b: IT use intensity to stimulate internal information flows has a positive impact on innovation program performance, mediated by market knowledge.*

### **The moderating role of the degree of servitization**

Manufacturing firms increasingly servitize their product-centric business models to provide services instead of, or in addition to, products (Vandermerwe and Rada, 1988; Lightfoot et al., 2013). These servitization strategies may include the offering of integrated product and service solutions, which Rolls-Royce Aerospace did with its product-service system of “power by the hour,” which allows customers to purchase aero engines’ capability (Neely, 2008). Since new services often arise ad hoc from direct interaction with customers (Gebauer et al., 2005), servitized firms have to cope with an emergent, interactive, and dynamic innovation process (Gallouj and Weinstein, 1997; Miles, 2008). This implies that information processing and, thus, achieving a high degree of overall market knowledge at the firm level become more challenging in the servitization context. This perspective can be further developed by drawing on the IHIP service characteristics: intangibility, heterogeneity, inseparability, and perishability (Fitzsimmons and Fitzsimmons, 2008). Despite criticism (Lovelock and Gummesson, 2004; Vargo and Lusch, 2004), these characteristics provide a theoretical foundation for explaining why information processing is more challenging for services. Service innovation relies on sticky and tacit information (Leiponen, 2006), and frequently lacks knowledge about customer preferences, due to customer needs’ heterogeneity and service delivery’s inseparability from its consumption (Carbonell et al., 2009; Den Hertog et al., 2010). To overcome this issue, customers need to be integrated into the service development processes to increase their efficiency and success (Jiménez-Zarco et al., 2011), thus building a complex service ecosystem (Spohrer et al., 2007, Wieland et al., 2012). Further, since services are intangible and perishable, competitors’ service activities in adjacent ecosystems are difficult to assess. Consequently, it is difficult for servitized firms to deduce market standards and to

differentiate themselves from their competitors. Owing to this inseparability, service innovation is also associated with the risk of critical information gaps between those employees in a firm's department without direct customer interaction and the front line employees who deliver a service to customers and have the relevant customer knowledge (Doerner et al., 2011). This problem becomes even more severe when one takes into consideration that service innovation often happens ad hoc, that most firms do not have a department dedicated to service development, and that service employees develop a service for specific customers without a link to the firm's overall strategy regarding innovation activities (e.g., Johne and Storey, 1998; Ettlie and Rosenthal, 2011; Blindenbach-Driessen and Van den Ende, 2014). Finally, information processing becomes more difficult due to the trend to develop and provide services in service ecosystems, which increases the amount of information and the efforts required to coordinate the information flows and activities between the partners (De Vries, 2006; Zhang et al., 2016).

Owing to these above service innovation characteristics, servitized firms face more challenges regarding gathering, processing, and distributing market-related information, although service innovations need as much external information as possible (Kang and Kang, 2013) to achieve a high service innovation performance (Jaw et al., 2010). If market knowledge is more difficult to build in firms which are intensely engaged in servitization, the relevance of market knowledge for performance might even be higher for servitized firms than for more product-centric firms due to the former's competitive advantage and higher success rates as a result of being better informed about the market. Consequently, firms with a higher degree of servitization and which achieve a high level of market knowledge throughout their organization might benefit more from their superior market knowledge than their less servitized peers. This leads to the conclusion that firms' degree of servitization strengthens the market knowledge's positive effect on innovation program performance.

*Hypothesis 2: The positive impact of market knowledge on innovation program performance is stronger (weaker) when the degree of servitization increases (decreases).*

### **Degree of servitization's impact on IT use intensity**

The degree of servitization may also have an impact on IT tools' use intensity. Previous research reported that servitized firm's performance benefits from implementing



IT tools (e.g., Nakata et al., 2008; Behera et al., 2015), although service innovation research has not provided empirical evidence of this. However, the characteristics of services and service innovation may explain servitized firms' lower IT use intensity. Services are developed and provided in close direct interaction with customers and service partners. Therefore, servitized firms pay less attention to establish additional IT tools for service innovation, because personnel or IT-based communication channels with customers and service ecosystem partners have often already been established (Chen and Tsou, 2012; Liu et al., 2015). Furthermore, customers' and service ecosystem partners' heterogeneity inhibits the broad use of IT tools (Barrett et al., 2015), because the partners in the firm's ecosystem may differ regarding their infrastructure, work procedures, and IT experience levels and, thus, reject the adoption of such tools. Consequently, a firm's stronger servitization focus may result in IT tools for external information flows having a lower use intensity.

Service innovation processes within a firm are usually less structured and developed than product innovation processes (Johns and Storey, 1998; Biemans et al., 2016). Service innovation activities are often delegated to operational business units, although many firms have no service development department to coordinate and undertake service innovation (Sundbo, 1997; Blindenbach-Driessen and Van den Ende, 2014). Consequently, no unit is responsible for developing, buying, and diffusing IT tools to connect the firm's dispersed employees who provide services and service innovations. However, even if IT tools are available, the sticky and tacit information associated with service innovations (Dotzel et al., 2013) complicates the codification of information (Jin et al., 2012). These arguments suggest that firms with a higher degree of servitization also use IT tools for internal information flows at a lower intensity.

*Hypothesis 3a: The IT use intensity for external information flows decreases with a higher degree of servitization.*

*Hypothesis 3b: The IT use intensity for internal information flows decreases with a higher degree of servitization.*

## Methods

### Data collection and sample

The hypotheses were tested with data from a cross-sectional industry sample of German and Austrian firms. Senior firm managers were contacted and informed of the study's purpose, which covers various aspects of innovation management. Those willing to participate nominated a set of employees who work with innovation tasks daily. Each of the employees was the best informant on the evaluation of the firm's practices and processes, as they evaluate these regularly. Subsequently, they received a link to an online survey, which includes the items to be assessed. A different survey was sent to one senior executive of each business unit to capture the overall innovation program performance and the degree of servitization, since these require a good overview of the organization's activities and outcomes. By using different informants, this multiple respondent design reduced the likelihood of common method bias. In total, this research draws on a sample of 887 informants from 116 firms (an average of 7.65 participants per firm) and their responses. The actual sample size exceeds the desired number of at least 110 firms, which draws on the recommendations of Chin (1998) who proposes 10 cases per predictor of the dependent variable with the largest number of predictors (in this case, this is eleven predictors of innovation program performance). The statistical power analyses (Cohen, 1992; Hair et al., 2016) also propose a sample size of at least 94 to detect  $R^2$  values  $\geq .25$  when considering a 5% probability of error, the commonly used level of statistical power of 80%, and the highest number of eleven arrows pointing to a dependent variable. Nine firms are located outside the study's geographical region, but have their headquarters in Austria. Table 3 summarizes other details about the sample characteristics. Non-response bias was assessed by comparing early respondents (first quantile) with late responding firms (last quantile), which were used as proxy for non-responding firms. None of the mean differences in the main model constructs of the two groups were significant, except for IT use intensity regarding internal information flows ( $\Delta=.70$ ;  $p<.05$ ). Given that early and late responding firms did not differ in their performance, the level of market knowledge, servitization, and-with one exception-in the other predictors, non-response bias is not an issue.

**Table 3. Sample characteristics**

<b>Industry</b>	<b>Number</b>	<b>Percent</b>	<b>Size (revenue; Mio. EUR)</b>	<b>Number</b>	<b>Percent</b>
Manufacturing goods (chemicals, food, plastics, glass, etc.)	46	39.7%	<10 Mio. 10-50	9 19	7.8% 16.4%
Industrial engineering (machine construction, plant engineering, etc.)	16	13.8%	51-250 251-500	36 11	31.0% 9.5%
Utilities (energy, water, recycling)	40	34.5%	501-1000 >1000	7 17	6.0% 14.7%
Others (information technology, industrial research)	14	12.1%	n.a.	17	14.7%
<b>Number of informants</b>			<b>Size (FTE)</b>	<b>Number</b>	<b>Percent</b>
2-3 informants	18	15.5%	<50 FTE	11	9.5%
4-5 informants	22	19.0%	50-250	47	40.5%
6-7 informants	35	30.2%	251-500	21	18.1%
8-9 informants	15	12.9%	501-1000	13	11.2%
10-20 informants	20	17.2%	>1000	24	20.7%
>20 informants	6	5.2%			
			<b>Country</b>		
<i>Total number of informants</i>	887		Austria	63	54.3%
<i>Average no. of informants by business unit</i>	7.65		Germany	44	37.9%
			other	9	7.8%

n=116.

## Measures

Reflective multi-item measures and five-point Likert-type scales were used for all of this study's multivariate constructs, which are reported in the appendix. Where possible, established indicators from prior research were used, while the development of new scales followed the corresponding literature closely. The developed measures' content validity was assessed via a pre-test in two workshops with practitioners from 20 organizations. Minor adaptations, based on the received feedback, were undertaken to the items' wording to remove the remaining ambiguities.

*Innovation program performance* was assessed at the portfolio level with six items from previous research (Griffin and Page, 1993; Manion and Cherion, 2009) that captured the innovation activities' performance impact over the previous three years. According to the for-profit focus of the industrial organizations investigated, the items measured the impact of the products' and the services' on the profitability, revenues, and market share, and on the quality and functionality, as well as the customer satisfaction. The senior management acted as the information source of the innovation program performance. Innovation team members-not including the senior manager who rated the performance-provided information on the IT use intensity and market knowledge.

*Market knowledge* was captured with nine items about the availability of meaningful and up-to-date market information for employees regarding the customer needs and demands, the market size and growth, the relevant competitors and their strengths, weaknesses, and business models, as well as the current market developments. The development of the items closely followed previous literature on market orientation that emphasized the acquisition and dissemination of market knowledge to enable the organization to respond appropriately to changes in the customer needs and in the competitive situation (Jaworski and Kohli, 1993; Zhou et al., 2005).

*IT use intensity for external information flows* focused on IT tools' use intensity regarding the management of information flows to and from external partners in the innovation process. IT use intensity was chosen as the relevant indicator to account for the different needs of a certain use frequency of specific IT tools. IT use intensity and use frequency express how much IT tools are applied in the organizational context. However, use frequency requires a time-based specification such as times per week, which differs significantly for the IT tools that were part of this scale. Intensively used social media can, for example, mean to use it daily while intensive use of data mining tools can mean to use it monthly. To overcome this tool-related frequency bias, the respondents rated to which extend the statement "We use tool [...] for [...]" applies to their organization. Drawing on related open innovation research (e.g., Von Hippel, 2001; Kozinets, 2002; Piller and Walcher, 2006; Franke et al., 2008), nine items were developed that probed whether the organization applied digital approaches, like netnography, used data mining, hosted online-communities, provided toolkits, and used crowdsourcing.

*IT use intensity for internal information flows* was assessed with four items that probed the intensity of the organizational IT use for employees when executing their innovation activities. This included, for instance, questions about the use of innovation process management software, internal web-based innovation platforms, and internal knowledge management tools. Therefore, scales from previous research were used (Barczak et al., 2007; Kawakami et al., 2015). The items reflected the availability of IT infrastructure that support the generation and distribution of innovation-related information and knowledge to stimulate the internal information flow and to facilitate internal communication and collaboration.

To assess the *degree of servitization*, the senior managers rated the importance of 12 industrial services (e.g., maintenance and repair, consulting and operating optimization, remote services, contracting, etc.) for their organization. The degree of servitization was then calculated as an index by using the average score across all the services. These overall service intensity scores of all the organizations were then mean-centered to calculate the relative intensity of each organization's servitization. Consequently, this study contributes to research by providing a more fine-grained measurement of the degree of servitization that goes beyond traditional industry classifications and accounts for the blurring boundaries between the product and service business.

More covariates were included in the model to control for the effects of organizational, industry sector, and environmental factors. Since the relevance of market information and performance levels may vary according to the uncertainty and dynamics of the organization's environment, *market and technology turbulence* were each captured with four items adapted from previous research (Venkatraman, 1989; Calantone and Garcia, 2003). In larger organizations, it may also be more difficult to diffuse market knowledge; therefore, the number of employees was used as a proxy for the *organization's size*. To avoid biases caused by extreme outliers, the absolute variable was recoded into six categories. In addition, it was controlled for the performance impact of the firms' operational and strategic proficiency on their innovation activities by adding two covariates. At the operational level, the *innovation process formality*, captured by means of four items from Schultz et al. (2013), indicates whether the firm has clearly defined stages and decision points for realizing innovation projects. The *strategic proficiency* was captured with 11 items adapted from Cooper et al. (2004), as well as Bart and Pujari (2007), to assess whether the firm has a formal innovation strategy that defines the innovation domains, which its employees know well, and which determines all the innovation activities, roles, and resource allocation decisions. Although all the organizations in the sample operated in the industrial context, further industry differences were controlled for by building dummy variables for four *industry sectors*: manufacturing goods, industrial engineering, utilities, and others. A dummy variable was entered in the model to control for *country differences*. The variables that were assessed by several respondents within an organization were aggregated to a firm-level score by calculating the mean values across their individual responses.

**Properties of the scales**

The applied measures were tested for validity and reliability. To assess the internal consistency, Cronbach's alpha coefficients were calculated, which ranged at satisfactory levels between .78 and .96. Principal component analyses (varimax rotation), which were conducted separately for each construct's items, only extracted one factor with eigenvalues greater than one, demonstrating these items' unidimensionality (Hair et al., 2009). Furthermore, partial least squares (PLS) path modeling's latest version in the software package SmartPLS 3 was used to assess the proposed model. The application of PLS is appropriate for research situations in which not all paths have previously been tested and the used measurement instruments are partly new. Furthermore, PLS outperforms complementary covariance-based path modeling techniques when a model is complex and the sample size is limited (Chin and Newsted, 1999; Henseler et al., 2009). To assess the significance of the loadings and paths, the resampling procedure, bootstrapping (Efron and Tibshirani, 1993), was applied, thus following the recent recommendations of 4,999 subsamples (Henseler et al., 2016). The PLS analysis supported the measurement model's indicator reliability, with all factor loadings being  $>.50$  and significant ( $p <.05$ ) (Hulland, 1999). Convergent validity was demonstrated by an average variance extracted of  $>.50$  for all constructs (Chin, 1998). Discriminant validity was assessed at the indicator and the construct level. The correlation of each item with its corresponding latent construct was bigger than its correlation with any other construct, and cross-correlations were clearly below .40. Discriminant validity at the construct level was supported by the results that the average variance extracted of each latent variable was greater than the highest squared correlation with all the other latent variables (Fornell and Larcker, 1981), and that, as an estimate of the upper boundary of the factor correlations, the HTMT were significantly smaller than one (Henseler et al., 2015). Finally, the variance inflation factors that test for potential multicollinearity were below the recommended threshold of 5 (Hair et al., 2016) for all predictors of all endogenous variables in the model.

The appropriateness of the individual responses' aggregation of several of the variables of firm-level scores was tested further by calculating the intra-class correlation coefficients (ICC) (1,k), which inform the inter-rater reliability and inter-rater agreement (Shrout and Fleiss, 1979). With the ICC (1,k) values between .67 and .89, the agreement on IT use intensities to stimulate external and internal information flows, as well as on market and technology turbulence, was considered moderate to strong (LeBreton and

Senter, 2008) and, thus, appropriate for aggregation. The ICC (1,k) was only lower for market knowledge (.34), which is intuitively conclusive, as the informants were from different functional areas and departments, not all of which deal with market-related issues. From this perspective, the aggregation is also valid, because the score represents the organization's overall market understanding. The means, standard deviations, correlations, and alpha coefficients are reported in Table 4, while further details on the loadings, t-values, average variance abstracted, and ICC(1,k) are listed in the appendix.

**Table 4. Mean, standard deviations, and correlation matrix**

Construct	Mean	S.D.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1. Country (1: Austria)	.54	.50	(-)										
2. Firm size	3.91	1.36	.01	(-)									
3. Market turbulence	3.07	.53	-.55 ***	-.14	(.82)								
4. Technology turbulence	2.71	.53	-.10	.04	.33 ***	(.87)							
5. Innovation process formality	2.71	1.27	.52 ***	.35 ***	-.55 ***	-.12	(.98)						
6. Innovation strategy	2.46	.71	.35 ***	.32 ***	-.39 ***	-.04	.70 ***	(.96)					
7. Degree of servitization	1.99	.80	-.09	-.11	.07	.24 *	-.19 *	-.19 *	(-)				
8. IT use intensity for internal inform. flows	2.23	.76	.28 **	.21 *	-.28 **	.02	.56 ***	.59 ***	-.18 *	(.78)			
9. IT use intensity for external inform. flows	1.84	.55	.06	.01	.13	.14	.17	.27 **	-.16	.51 ***	(.88)		
10. Market knowledge	3.53	.44	.18 *	.07	-.03	-.08	.29 **	.38 ***	-.19 *	.36 ***	.44 ***	(.93)	
11. Innovation program performance	3.37	.67	.26 **	.02	-.21 *	.17	.32 ***	.43 ***	.03	.26 **	.18 *	.38 ***	(.80)

<sup>a</sup> S.D., standard deviation. Cronbach's alpha reported along the diagonal.

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$  (two-tailed).

n=116.

## Results

### Main Effect Model

The size, sign, and significance of the path coefficients inform the strengths of the relationships to test the proposed hypotheses. Furthermore,  $R^2$  indicates the percentage of variance explained by the predictors of a dependent variable (Chin, 1998). The adjusted  $R^2$  values are reported, which also takes the model's complexity and the sample size into

account. The effect size  $f^2$  quantifies whether the significant effects are weak ( $f^2 >.02$ ), moderate ( $f^2 >.15$ ), or strong ( $f^2 >.35$ ) (Cohen, 1988). Owing to the multiple mediations in the model, the indirect and total effects were also calculated (Zhao et al., 2010), thereby following the approach proposed by Henseler et al. (2016) to integrate the categorical control variable industry on four levels. A dummy variable was generated for each industry. Thereafter, a composite model was formed for the industry sectors manufacturing, industrial engineering, and utilities from the dummy variables. The remaining dummy variable to capture all other industries characterized the reference level. Table 5 presents the results of the main effects.

The results support hypotheses H.3a and H.3b, which proposed that the degree of servitization has a negative effect on IT use intensity for external information flows ( $\beta=-.17$ ;  $p=.045$ ) and on IT use intensity for internal information flows ( $\beta=-.23$ ;  $p=.008$ ). The effect sizes are weak to moderate ( $f^2=.03$ , and  $.05$ ).

As expected, IT use intensity for external information flows increases market knowledge ( $\beta=.32$ ;  $p=.006$ ). Furthermore, IT use intensity for internal information flows has a positive effect on market knowledge ( $\beta=.20$ ;  $p=.040$ ). Both exert a weak to moderate effect on market knowledge ( $f^2=.09$  and  $.03$ ). The effect of market knowledge on innovation program performance is positive and significant ( $\beta=.33$ ;  $p=.005$ ;  $f^2=.12$ ). IT use intensity for external information flows ( $\beta=-.04$ ;  $p=.347$ ) and IT use intensity for internal information flows ( $\beta=-.03$ ;  $p=.410$ ) have no direct performance impacts. Together, these results support Hypotheses H.1a and H.1b. The indirect effect of IT use intensity for external information flows on innovation program performance through market knowledge is  $.11$ , while that for internal information flows is  $.07$ . Their total effects, which also consider the direct effects on performance, are  $.07$  and  $.04$  for the IT use intensity for external and internal information flows. The degree of servitization does not impact market knowledge directly ( $\beta=-.06$ ;  $p=.270$ ), but has an indirect effect ( $-.10$ ) through its impact on IT use intensity for internal and external information flows. None of the effects of the control variables market and technology turbulence, size, country, and industry sector is significant. In total, the variables explain 23% of the market knowledge variance. As control variables, both the technology turbulence ( $\beta=.28$ ;  $p=.002$ ;  $f^2=.11$ ) and the innovation strategy proficiency ( $\beta=.27$ ;  $p=.022$ ;  $f^2=.05$ ) have a significant positive effect on innovation program performance. In total, the predictors explain 32% of innovation program performance's variance.



**Table 5. Main model results**

Hypothesis	Independent	Dependent	$\beta$	p	Adj. R <sup>2</sup>	f <sup>2</sup>	Indirect effect	Total effect
H.3.a	Degree of servitization	→ IT use intensity for external information flows	-.17 *	.045	.02	.03	(-)	-.17
H.3.b	Degree of servitization	→ IT use intensity for internal information flows	-.23 **	.008	.04	.05	(-)	-.23
H.1.a	IT use intensity for external information flows	→ Market knowledge	.32 **	.006	.23	.09	(-)	.32
H.1.b	IT use intensity for internal information flows	→	.20 **	.040		.03	(-)	.20
	Degree of servitization	→	-.06	.270		.00	-.10	-.16
	Market turbulence	→	.10	.321		.01	(-)	.10
	Technology turbulence	→	-.07	.360		.01	(-)	-.07
	Firm size	→	.02	.421		.00	(-)	.02
	Industry	→	.10	.289		.01	(-)	.10
	Country	→	.11	.165		.01		.11
	Market knowledge	→ Innovation program performance	.33 **	.005	.32	.12	(-)	.33
	IT use intensity for external information flows	→	-.04	.347		.00	.11	.07
	IT use intensity for internal information flows	→	-.03	.410		.00	.07	.04
	Degree of servitization	→	.07	.178		.01	-.04	.03
	Market turbulence	→	-.10	.197		.01	.03	-.07
	Technology turbulence	→	.28 ***	.002		.11	-.02	.26
	Firm size	→	-.12	.080		.02	.01	-.11
	Innovation process formality	→	-.09	.274		.00	(-)	-.09
	Innovation strategy	→	.27 *	.022		.05	(-)	.27
	Industry	→	.22	.111		.03	.03	.25
	Country	→	-.03	.398		.00	.04	.01

<sup>a</sup>  $\beta$ , path coefficient; p, level of significance; Adj. R<sup>2</sup>, adjusted explained variance; f<sup>2</sup>, effect size

\* p < .05; \*\* p < .01; \*\*\* p < .001 (one-tailed).

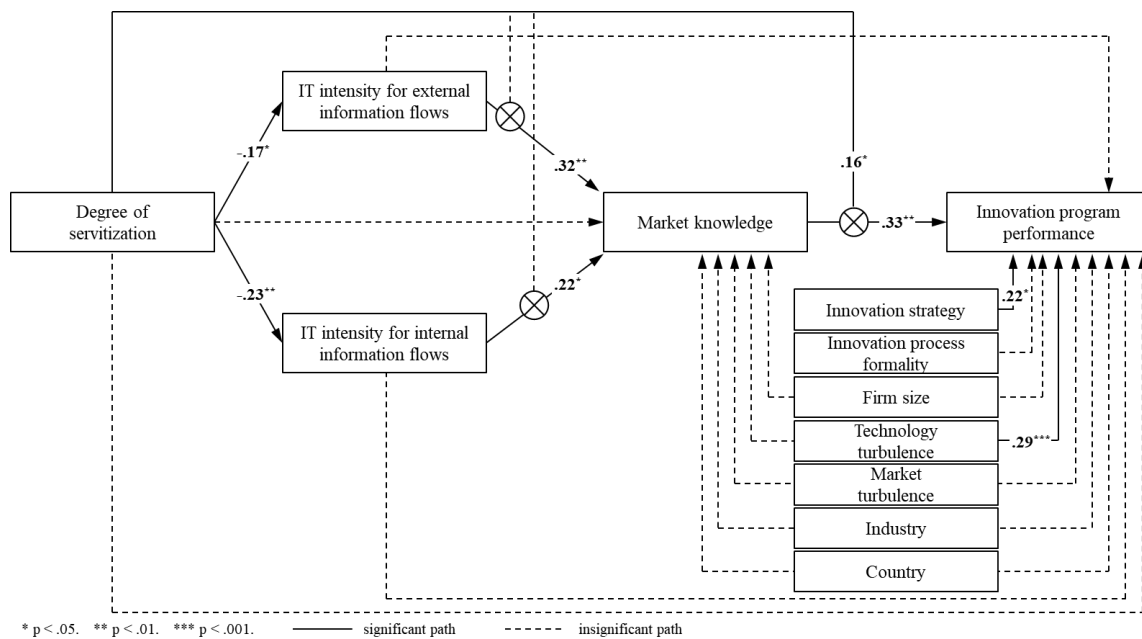
n=116.

### Moderation analysis

To test hypothesis H.2, which proposes that the strength of the relationship between market knowledge and innovation program performance depends on the degree of servitization, the main model was extended by integrating a moderation effect. In addition, it was controlled whether the impacts of IT use intensity for internal and external information flows on the market knowledge are also contingent upon the degree of servitization. To test the moderation effects, the two-stage approach was applied, which draws on the latent variable scores estimated in the main model to calculate the interaction term. This approach is recommended if not both variables are measured with reflective

indicators as for the moderator, the degree of servitization. (Chin et al., 2003; Henseler and Chin, 2010). The results are summarized in Table 6.

While the effects of the main model remained the same, the interaction term testing whether the market knowledge-performance relationship is contingent upon the degree of servitization is positive and significant ( $\beta=.16$ ;  $p=.044$ ). Thus, the empirical data support hypothesis H.2. In addition, it was tested whether the relationship between IT use intensity for internal and external information flows and market knowledge depends on the degree of servitization, but the data does not reveal a significant effect. The presented results are summarized in Figure 1.



**Figure 1. Model and path coefficients**

**Table 6. Moderation model results**

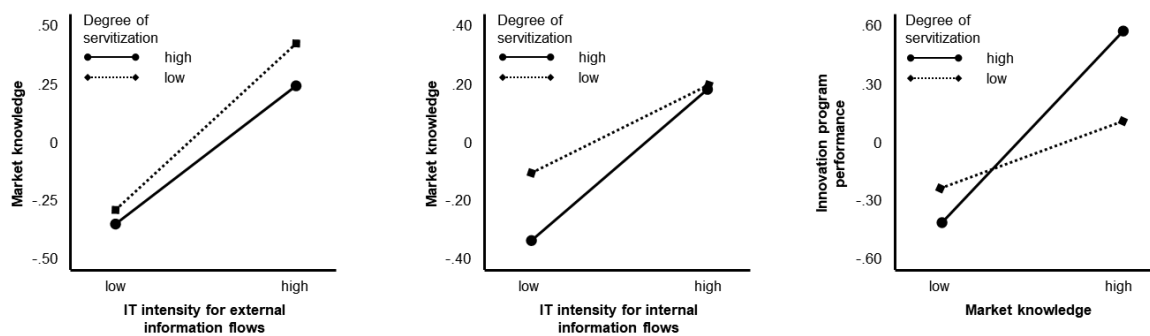
Hypothesis	Independent	Dependent	$\beta$	p	Adj. R <sup>2</sup>	f <sup>2</sup>	Indirect effect	Total effect
	Degree of servitization	→ IT use intensity for external information flows	-.17 *	.042	.02	.03	(-)	-.17
	Degree of servitization	→ IT use intensity for internal information flows	-.23 **	.009	.04	.05	(-)	-.23
	IT use intensity for external information flows	→ Market knowledge	.32 **	.009		.08	(-)	.32
	IT use intensity for internal information flows	→	.22 *	.029	.22	.03	(-)	.22
	Degree of servitization	→	-.06	.283		.00	-.10	-.16
	Market turbulence	→	.09	.324		.01	(-)	.09
	Technology turbulence	→	-.07	.361		.01	(-)	-.07
	Firm size	→	.01	.455		.00	(-)	.01
	Industry	→	.11	.289		.01	(-)	.11
	Country	→	.11	.187		.01	(-)	.11
	Degree of servitization x IT use intensity for external information flows	→	-.02	.420		.00	(-)	-.02
	Degree of servitization x IT use intensity for internal information flows	→	.06	.287		.00	(-)	.06
	Market knowledge	→ Innovation program performance	.33 **	.001	.34	.12	(-)	.33
	IT use intensity for external information flows	→	.01	.472		.00	.11	.11
	IT use intensity for internal information flows	→	-.02	.444		.00	.07	.05
	Degree of servitization	→	.07	.206		.01	-.05	.02
	Market turbulence	→	-.13	.138		.01	.03	-.10
	Technology turbulence	→	.29 ***	.001		.12	-.02	.27
	Firm size	→	-.10	.135		.01	.00	-.10
	Innovation process formality	→	-.12	.214		.01	(-)	-.12
	Innovation strategy	→	.22 *	.045		.03	(-)	.22
	Industry	→	.27	.083		.05	.03	.31
	Country	→	-.03	.405		.00	.04	.01
<b>H.2</b>	<b>Degree of servitization x Market knowledge</b>	→	<b>.16 *</b>	<b>.044</b>		<b>.04</b>	(-)	<b>.16</b>

<sup>a</sup>  $\beta$ , path coefficient; p, level of significance; Adj. R<sup>2</sup>, adjusted explained variance; f<sup>2</sup>, effect size

\* p < .05; \*\* p < .01; \*\*\* p < .001 (one-tailed).

n=116.

The plots of the simple slope analyses – depicted in Figure 2 – graphically illustrate the strength of the independent variable’s effect on the dependent variable regarding the low (mean minus one standard deviation) and high (mean plus one standard deviation) moderator levels of all three moderation effects. The first two plots show that the positive relationships between the IT use intensity for internal and external information flows and market knowledge are almost identical for both levels of servitization, which the parallel lines with similar slopes for low and high servitization levels illustrate. The third plot for the significant moderation effect of the relationship between market knowledge and innovation program performance illustrates this effect with the higher slope of the line for a high level of servitization ( $\beta=.49$ ) than for a low level of servitization ( $\beta=.17$ ).



**Figure 2. Plots of moderation effects**

## Discussion

Since firms invest significantly in implementing and operating IT tools, this article improves the understanding of (i) the relevance and functioning of IT tools to improve the firm’s overall innovation performance, and (ii) the role that servitization plays in applying IT tools. This study therefore conceptually drew on organizational information processing theory and the service innovation literature, and then tested the conceptual model with empirical field survey data.

The results show that IT tools support the information flows with external stakeholders and within the firm. The results also show that IT tools assist the organizational members to develop a better knowledge about the market, which, in turn, improves the overall performance of the firm’s innovation activities at a program level. These findings are

consistent with previous research about IT tools in innovation management that could not find a direct relationship between IT tools and performance (e.g., Barczak et al., 2007; Marion et al., 2016; Mauerhoefer et al., 2017). By identifying market knowledge as a relevant mediator, the findings fit the general propositions of the broader innovation literature that the firm's knowledge about its customers and competitors requires superior information processing (Kohli and Jaworski 1990; De Luca and Atuahene-Gima, 2007) and increases the ability to meet customer needs and efficiently master innovation activities (Narver and Slater, 1990; Atuahene-Gima, 1995; Henard and Szymanski, 2001).

The results also correspond to studies, which demonstrate that internally directed IT tools improve the information flows in cross-functional innovation teams (e.g., Song and Song, 2010, Marion et al., 2014), whereas externally directed IT tools support market-related decisions (Barczak et al., 2007). In addition to providing a theoretical foundation by focusing on organizational information processing theory, this research shows the impact of IT tools at the innovation program level, and this is an essential extension of prior project-based studies.

Regarding the firm's business focus, the results introduce the degree of servitization as an important contingency factor of IT use. Firms, which have a stronger emphasis on the service business, gain more benefits from market knowledge throughout their organization than their product-centric peers. In consideration of the mediation effect, it is noteworthy that the total effect of IT tools, which support internal and external information flows, on innovation program performance is more pronounced for firms with higher degrees of servitization (.09 and .16 when servitization plus one standard deviation) than for those with a lower degree of servitization (.02 and .06 when servitization minus one standard deviation). This finding supports previous research, which emphasized that, in order to innovate services, it require more effort to build the necessary market understanding to succeed, due to the stickiness of information, the heterogeneity of customer needs, and the involvement of multiple service partners (e.g., Leiponen, 2006; Jaw et al., 2010; Kang and Kang, 2013). These results go beyond existing research by providing theoretical arguments and empirical evidence that service innovations require higher information processing capabilities (e.g., intensive use of IT tools as structural mechanisms) to overcome uncertainty in complex service ecosystems.

This article also shows that the use of IT tools becomes more difficult when the degree of the firm's servitization increases. This finding is in line with previous lines of argument in the service innovation context, namely that firms who apply IT tools face more difficulties, predominantly because the tasks are less structured and involve more stakeholders (e.g., Johne and Storey, 1998; Jaakkola et al., 2017). The data shows that the likelihood of IT tools being applied-for both internal and external information flows-decreases when the service focus of the firm increases.

All in all, the identified effects of servitization imply a dilemma for servitized firms, because it exposes a gap between the required level of IT use intensity and firms' current use. The adoption of IT tools fails more often when firms achieve a higher degree of servitization, although these firms benefit even more from market knowledge than their product-centric counter-parts. This can help to explain the service paradox that is the failure of service strategies in product-oriented firms despite their benefits (e.g., Gebauer et al., 2005). Despite extensive servitization research, the understanding of the service paradox, its underlying barriers, and the capabilities that are required to overcome servitization failure, remains limited (Kowalkowski et al., 2017; Story et al., 2017). In line with this service paradox the results show that there is no overall difference-in terms of innovation program performance-between companies with a high degree of servitization and companies with a lower degree of servitization (.02 total effect of degree of servitization on innovation program performance). The results therefore reveal that servitization strategies may only result in higher firm innovation performance, if firms invest in the development of information processing capabilities from which servitized firms benefit more, even if it is more difficult for them to establish.

## **Implications and Limitations**

### **Theoretical Implications**

Although innovation management literature began to examine the role of IT use and efficacy in innovation processes, the underlying mechanisms in the relationship between IT tool use and innovation performance are still not clarified (Durmuşoğlu et al., 2006; Barczak et al., 2007; Durmuşoğlu and Barczak, 2011). This study contributes to this field in the following three ways:

First, this study expands the understanding of potential mediators in the relationship between IT use and innovation program performance by introducing market knowledge as a result of efficient information processing. It shows that both internally directed IT tools (e.g., knowledge sharing tools) and externally directed IT tools (e.g., crowdsourcing) result in firm-wide market knowledge. In this respect, this article expands the information processing theory by showing that internal, as well as external, information processing activities lead to decreased environmental uncertainty, which, in turn, makes innovation success more likely. This study also explains the value of applying a program view rather than a project perspective to fully explore the firm-wide effect of IT tools that facilitate the information flows. This seems to be the appropriate level of analysis, because IT tools are part of the innovation management system that affects and links all the firm's innovation activities, instead of being installed merely for a specific project.

Second, this study identified the firm's specific business focus as a key contingency factor. Existing studies about information processing theory and (service) innovation largely ignore the role of servitization (e.g., Zhang et al., 2016), although the business focus determines a firm's information processing requirements, applied practices, and achieved performance. This article contributes to the literature about information processing by showing that an increasing degree of servitization leads to a lower IT use intensity, which hampers the required internal and external information processing capabilities. This also underlines the relevance of organizational challenges when firms aim to increase their degree of servitization (Luetjen et al., 2017). Considering the degree of servitization, this study also contributes to the discussion about the relevant moderators in the relationship between market knowledge and innovation performance (e.g., De Luca and Atuahene-Gima, 2007).

Third, this article responds to the call for an improved measurement of firms' service focus (e.g., Hipp and Grupp, 2005) by providing a fine-grained measurement for the degree of servitization. Unlike previous studies that distinguish between service and manufacturing firms in terms of industry codes and sector classifications, this study focuses on how relevant specific services are for the firm, thereby capturing the entire continuum of relevant service types. The study also considered the blurred boundaries between product and service businesses by assessing the firm's business focus (Vargo and Lusch, 2004).

## **Managerial Implications**

Based on the proposed and empirically tested model, several recommendations can be derived for managers. First, managers who aim at higher innovation program performance ought to prioritize gathering, processing, and distributing market information, regardless of their firm's business focus. Investments into IT tool installations that help employees to collect and interact with external stakeholders in their ecosystem, as well as IT tools that facilitate the internal information and knowledge exchange between the organization's members, departments, and business units, will not only build a better firm-wide market knowledge, but will also result in more successful innovation activities. The demonstrated effect at the program level indicates that these IT tools should be established firm-wide and not for specific projects only.

Second, besides investments into the necessary infrastructure, all relevant employee groups should have access, receive training, and be encouraged to apply these IT tools. The managers at one of the investigated firms decided to introduce a new idea and knowledge management system with the intention to collect all ongoing innovation projects and to provide insights-to other innovation project teams-into customer needs, technical solutions, failures, etc. After a while, the managers were quite surprised to find that no one used their system. After investigating the matter, they found that the employees did not use the tool, due to complex access rights regulations, forced entry fields, limited usability, and a shared skepticism about the actual purpose of the system. The managers provided introductory training, and presently all innovation project teams use the IT tool as their main approach for project documentation and idea management. The managers thus learned that installing IT is worthless without managing it.

Third, if managers want to strengthen their firm's service focus or already have a strong service business, they need to be aware that their firm's market knowledge becomes even more critical for success. Service innovations are complex, rely on tacit knowledge, and involve multiple stakeholders, such as customers. This makes information processing more challenging. The findings show that firms with a stronger emphasis on services, tend to use IT tools-to facilitate internal and external information flows-less intensely. The management at one of the servitized firms reported that they were not able to include external service partners in the existing IT infrastructure. Involving several departments made processes very bureaucratic and resulted in the use of several different and very rigid IT tools. The managers learned that they should have organized their existing IT system



flexible, open, and modular to be able to involve their service partners and develop services agilely. This can indeed result in additional investments, but from a managerial perspective they are well justified, given the crucial role that a servitized firm's information processing capabilities plays in gaining market knowledge and improving the overall innovation performance.

### **Limitations and Future Research**

Despite its contributions, this study has certain limitations that need to be taken into account. First, the model specifies that market knowledge fully mediates the impact of internal and external IT use intensity on innovation program performance. However, with respect to this complex relationship (e.g., De Luca und Atuahene-Gima, 2007), other mediators (e.g., collaboration quality) may exist which could shed light on the existing black box regarding the relationship between IT use intensity and market knowledge. Additionally, it is possible that several complementary assets reinforce, or mitigate, the IT effect on market knowledge. Relevant aspects may be leadership, team cohesion, and motivational issues.

Second, this study focuses on the degree of servitization as relevant for the relationship between market knowledge and innovation program performance. Again, other issues may contribute to a better understanding of the market knowledge-performance relationship. For instance, future studies might investigate the availability of resources, or cultural aspects, which may impact how market knowledge actually translates into portfolio performance. A lack of R&D resources, or a strong technological orientation, might inhibit a superior understanding of customer needs being used in innovation projects, which maintains the misfit between the market needs and the firm's offerings.

The results indicate the dilemma of the current and desired level of IT use for firms with a strong service focus; further research should therefore investigate further barriers that prevent firms from using information technology. For example, scholars might examine whether the use of IT tools differs for different types of services, as they might be easier to use in the context of standardized services than of customized services. The use of IT tools might also differ depending on the innovation program's desired degree of innovativeness. Radical service innovations might require different information (e.g., latent needs) than incremental innovation (e.g., machine data from already used machines), which

might also impact the IT tools that are used more or less intensely. In addition, the implementation and maintenance of sophisticated IT systems require significant financial and organizational resources. Hence, future research can address the role of such complementary resources for IT tool efficacy and efficiency.

Finally, the survey study design is limited with regard to examine the causality of the proposed relationships. Future studies could apply a longitudinal research design to deepen the understanding of how, and under which conditions, IT instruments affect innovation program performance. This would also allow researchers to focus on the reinforcing effects of market knowledge on the degree of servitization, as the latter should benefit from market needs' greater transparency. Furthermore, this empirical analysis draws on data from multiple respondents (7.73 participants per firm) to limit common method bias; but future research could employ secondary data to assess the firm's innovation program performance.

Despite these limitations, this study provides valuable insights into the effects of internal and external IT use intensity on innovation program performance, and improves the understanding of service innovation management.

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**Appendix 1. Measures, corresponding factor loadings, and psychometric properties<sup>a</sup>**

Construct/Respondent	Items	Factor loading	t-value
<b>Market turbulence</b>	( $\alpha=.82$ , AVE=.63, ICC(1,k)=.70)		
Respondents: mean of innovation team member's responses	(1=strongly disagree, 5=strongly agree)		
	Many new competitors are active in the market.	.92	4.70 ***
	The competitive conditions in the market are unpredictable.	.65	2.95 **
	Many new value chain partners (suppliers, service partners) are active in the market.	.85	4.20 ***
	Business models often change in the market.	.73	3.80 ***
<b>Technology turbulence</b>	( $\alpha=.87$ , AVE=.68, ICC(1,k)=.71)		
Respondents: mean of innovation team member's responses	(1=strongly disagree, 5=strongly agree)		
	Our industry often experiences technological breakthroughs.	.89	6.70 ***
	The technologies applied in our industry are constantly changing.	.86	7.47 ***
	Technologies from different technological fields are often combined in our industry.	.91	6.90 ***
	New technologies in our industry often trigger business model changes.	.60	3.07 ***
<b>Innovation process formality</b>	( $\alpha=.98$ , AVE=.96, ICC(1,k)=.89)		
Respondents: mean of innovation team member's responses	(1=strongly disagree, 5=strongly agree)		
	Our company uses a formal innovation process, e.g. a standardized set of stages and go/no-go decisions that guide all innovation activities from the idea through to market launch.	.97	104.69 ***
	Our standardized innovation process lists and defines specific activities for each phase of the process (e.g. the validation stage contains activities such as prototype tests and customer tests).	.98	229.23 ***
	Our standardized innovation process includes clearly defined go/no-go decision points for each stage of the process.	.98	237.70 ***
	Our standardized innovation process defines 'gate keepers,' whose task it is, e.g. to review the activities at each stage of the process, as well as decide on whether to continue or abort the project.	.97	126.96 ***
<b>Innovation strategy</b>	( $\alpha=.96$ , AVE=.73, ICC(1,k)=.71)		
Respondents: mean of innovation team member's responses	(1=strongly disagree, 5=strongly agree)		
	We have an innovation vision documented in writing.	.76	10.74 ***
	We have an innovation strategy documented in writing.	.89	41.26 ***
	The innovation strategy is widely known in the organization and understood by everyone.	.89	39.98 ***
	The innovation strategy is defined with the involvement of a broad employee base.	.75	14.25 ***
	Our innovation strategy specifies who is responsible for its implementation.	.89	41.11 ***
	We have clearly defined what we consider to be innovation and what is deemed daily business.	.85	27.55 ***
	The strategic areas our innovation activities are focused on are clearly defined, e.g. markets, product areas, industries, technologies.	.90	40.98 ***
	All innovation activities are determined by the innovation strategy.	.87	41.93 ***
	Resources for innovation activities are allocated in accordance with the defined strategic areas.	.82	22.79 ***
	There is a clear link between our corporate strategy and the set innovation strategy.	.91	44.06 ***
	The innovation strategy contributes to the achievement of the strategic corporate objectives.	.87	36.86 ***
<b>Innovation program performance</b>	( $\alpha=.80$ , AVE=.51)		
Respondents: CEO	(1=strongly disagree, 5=strongly agree)		
	Our innovation activities have contributed to the success of our firm within the last three years with respect to ... profitability	.70	11.48 ***
	... revenue	.79	16.27 ***
	... market share	.78	12.24 ***
	... product/service quality	.70	13.11 ***
	... product/service functionality	.61	7.49 ***
	... customer satisfaction	.66	10.72 ***

**Appendix 1. (continued)<sup>a</sup>**

Construct/Respondent	Items	Factor loading	t-value	
<b>Market knowledge</b> Respondents: mean of innovation team member's responses	( $\alpha=.93$ , AVE=.63, ICC(1,k)=.34) (1=strongly disagree, 5=strongly agree)			
	We have access to meaningful and up-to-date information about...			
	...the problems and needs of our customers.	.87	28.75	***
	...customer segments.	.89	31.68	***
	...the size and growth of our target markets.	.86	24.84	***
	...the price sensitivity of our target customers.	.85	20.42	***
	...the expected sales and turnover of our new products/services.	.76	14.53	***
	We know our competitors' business models.	.66	8.90	***
	...the competitive situation, e.g. relevant strengths and weaknesses of competitors, product/service differences and positioning.	.84	16.07	***
	...the environmental conditions in the target market, e.g. legal framework conditions, social and political conditions.	.81	14.09	***
We know our customers and understand how the work of each employee can help create benefits to customers.	.54	4.65	***	
<b>IT use intensity for external information flows</b> Respondents: mean of innovation team member's responses	( $\alpha=.88$ , AVE=.58, ICC(1,k)=.67) (1=strongly disagree, 5=strongly agree)			
	We systematically analyze online forums and social networks (netnography).	.75	11.26	***
	We perform systematic data mining, e.g. recording and analyzing the operating data of our sold products/services.	.68	10.13	***
	We host our own online community that supports us in the development of products/services.	.83	16.73	***
	We provide our customers various means of having discussions with one another and observe their communication, e.g. through peer assistance via a web platform.	.69	6.60	***
	We use web-based toolkits for the development of products/services.	.65	6.68	***
	We use crowdsourcing to generate ideas when developing products/services.	.83	17.45	***
	We use crowdsourcing to assess ideas when developing products/services.	.88	24.29	***
<b>IT use intensity for internal information flows</b> Respondents: mean of innovation team member's responses	( $\alpha=.78$ , AVE=.59, ICC(1,k)=.82) (1=strongly disagree, 5=strongly agree)			
	We use specific software to support our innovation process.	.87	18.67	***
	We use IT solutions to analyze the data collected.	.80	17.69	***
	We use web-based tools to generate, gather, and assess ideas, e.g. idea competitions, virtual idea platforms, and innovation games.	.82	11.99	***
	Knowledge sharing is supported by an IT tool in our company, e.g. knowledge database and wikis.	.54	4.26	***
<b>Degree of servitization</b> Respondents: CEO	(Average over all services and mean centered) (1=not important at all, 5=very important)			
	How important are the following product-supporting services offered by your company or strategic business unit for the success of your company?			
	... maintenance, repairs, and servicing			
	... commissioning, transport, and assembly			
	... planning and offering multi-provider solutions			
	... instructing and training customers			
	... consulting and operating optimization			
	... spare parts management			
	... hotline and telephone support			
	... analysis of operating data			
	... teleservice and remote service (condition monitoring)			
	... preventative maintenance			
	... contracting (complete assumption of product operation)			
	... sharing (use of the product by multiple customers)			

<sup>a</sup>  $\alpha$ , Cronbach alpha. AVE, average variance extracted. ICC(1,k) intra-class correlation coefficient.  
 \*\* p < .01; \*\*\* p < .001 (two-tailed).  
 n=116.

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## **Paper 2: Sustain(able) urban (eco)systems: Stakeholder-related success factors in urban innovation projects**

Julia Kroh

### **Abstract**

Urban areas are centers for social life, financial, and industrial activities, and, therefore, are high consumers of resources and energy. Consequently, sustainable urban transformation is becoming increasingly relevant to counter climate change. However, cities are complex and adaptive (eco)systems characterized by constant underlying change, and urban innovation allows the cooperation and acceptance of various stakeholders. For example, establishing complex system innovations, like energy-efficient heating and mobility infrastructures, is associated with several implementation challenges that will, nevertheless, improve a city's overall sustainability. The complex adaptive systems (CAS) perspective allows an exploratory analysis of the intricate stakeholder interactions and urban innovation processes as a mean to achieve urban transformation in urban ecosystems. In the sense of innovative urban restructuring of, for example, stakeholder alliances, industrial sites, and urban districts, urban innovations may face specific innovation barriers. Recognizing such barriers may help prevent innovation resistance. Consequently, implementing urban innovations depends on innovation drivers, because these innovations can fail if stakeholders do not accept them, due to their implementation depending greatly on the willingness of stakeholders to adopt them. Based on a qualitative content analysis with data from 20 semi-structured interviews from 7 urban innovation project teams, the author identifies an urban innovation development process and urban innovation specific innovation drivers and barriers. In addition, based on a fuzzy-set qualitative comparative analysis (fsQCA) with data from 33 German urban innovation projects, the author shows that urban innovation implementation necessarily relies on detailed feasibility checks of the developed innovation alternatives, and on transparent and comprehensible stakeholder communication in the development and implementation process. Thus, urban transformation is not achievable without close stakeholder collaboration. Furthermore, the fsQCA delivers a toolbox to successfully implement urban innovations by means of different innovation drivers.

Keywords: urban innovation; urban transformation; complex adaptive systems; institutional theory; change management; ecosystem; sustainable city; innovation resistance; fuzzy-set qualitative comparative analysis

## **Introduction**

The need for sustainable urban transformation is becoming increasingly relevant to counter global climate change for the following reasons (e.g., Joss, 2015): First, urban areas' high energy and resource consumption rates mean that they are responsible for most man-made emissions. Second, cities are centers of financial and industrial activities, and therefore important for economic progress and innovation development. Third, the world population is growing steadily, with more than half living in urban areas (United Nations, 2018). Consequently, there is an increased demand for smart and integrated urban solutions like smart cities (Zygiaris, 2013; Khomsi, 2016). However, urban transformation requires the implementation of innovations to ensure that cities' future ecological needs will be met. In turn, this requires various public and private stakeholder groups' cooperation and acceptance. Recent innovation management research does not consider urban innovations as a stand-alone innovation type, despite the increase of their practical, social, and theoretical relevance. To date, there are policy papers rather than theory-driven research on such urban innovations. This study provides a broad literature overview of the emerging urban innovation research field and, by drawing on complex adaptive systems (CAS) theory, investigates urban innovation processes by means of an explorative approach. The study deepens our understanding of the urban ecosystem and the contingencies of urban innovation processes, thereby extending the new urban innovation research field.

Cities are complex and adaptive ecosystems characterized by constant underlying change, and urban innovation allows the cooperation and acceptance of various public and private stakeholders. For example, the establishment of complex system innovations, like energy-efficient heating and mobility infrastructures, is associated with various implementation challenges that will, nonetheless, improve a city's overall sustainability. In other words, the city is a difficult and decentered object with a multiplicity of processes and sociotechnical networks, as well as with hybrid collectives and alternative typologies (Farías and Bender, 2010; Gutzmer, 2016). Thus, inducing change to achieve sustainability is challenging, because this is only possible through sociotechnical transition, that is the

adoption of technological innovations in a complex social system (Geels et al., 2017; Canitez, 2019). It is not always possible to achieve economic, ecologic, and social sustainability at the same time (e.g., Amin and Thrift, 2002; Joss, 2015), which requires the deinstitutionalization of public and private institutions (DiMaggio and Powell, 1983; Berrone et al., 2013). For example, smart city initiatives pursue sustainability goals by implementing information technologies (e.g., Appio et al., 2019). Eco and low-carbon city initiatives, like the French initiative *ÉcoQuartier*, aim to achieve ecological sustainability by reducing carbon emissions and increasing energy efficiency (Joss, 2015). Such initiatives should therefore encourage innovations and investments in sustainable urban development and induce a process of institutional change by means of regulatory and normative pressure (Metz et al., 2016).

The CAS perspective allows an exploratory analysis of the complex stakeholder interactions and urban innovation processes as a mean to achieve urban transformation in urban ecosystems (Anderson, 1999; McCarthy, 2003; Levy and Liechtenstein, 2012; Roundy et al., 2018). These interactions are specifically important for the implementation of innovations in urban areas (e.g., Murdoch, 2000; Allen, 2001; McCarthy et al., 2006). However, the urban ecosystem's structure (e.g., Moore, 2006) has not yet been clarified. Although it is well-known that a number of different stakeholders are relevant for urban innovation, it is not clear which key stakeholder groups are relevant for which specific implementations. Additionally, the urban innovation process is not clear either. Drawing on the CAS perspective, stakeholders' behavior in urban innovation relies on their habits, their networks, and the coevolution with other stakeholder groups (e.g., Reiman et al., 2015). These characteristics underline the complexity of urban innovation development and implementation from a project management perspective. Consequently, the first research question is: *How is innovation development in complex adaptive urban systems designed?*

In the sense of innovative urban restructuring of, for example, stakeholder alliances, industrial sites, and urban districts (Dente and Coletti, 2011; Mieg, 2012), urban innovations may face specific innovation barriers and recognizing such barriers may help prevent innovation resistance. Although the city is a fuzzy ecosystem, its stakeholders, like its government and residents, are often highly institutionalized and thus bound to tight structures and routines. By nature, stakeholders fear change and are skeptical of all activities representing change (March and Simon, 1958). Accordingly, implementing



innovations to achieve urban transformation will face resistance (Landry, 2012). Therefore, the second research question is: *Which specific barriers does urban innovation implementation face?*

Consequently, implementing urban innovations depends on innovation drivers, because these innovations can fail if stakeholders do not accept them, due to their implementation depending greatly on the willingness of stakeholders to adopt them. Reducing stakeholders' resistance by means of a structured innovation process is therefore very important. Change management recommends strategies to mobilize stakeholders to implement innovations (e.g., Lewin, 1947; Kotter, 1996; By, 2005; Appelbaum et al., 2012). Nevertheless, facing urban innovations' complexity, change management strategies and innovation drivers need to be adjusted to urban innovations' specific barriers, leading to specific urban innovation success factors. Therefore, the third research question is: *Which success factors remove barriers and implement urban innovations?*

Based on 20 semi-structured interviews with experts from seven urban innovation projects and additional short interviews with experts from a further 26 urban innovation projects, a mixed-method approach, as well as an in-depth analysis of urban innovation literature, the author explains sustainable urban transformation and refers explicitly to the implementation of urban innovations in the sense of innovative urban restructuring. Given the complex and systemic structure of a city's ecosystem, urban innovation is introduced as a stand-alone innovation type that faces stakeholder-specific innovation barriers and drivers. The study thus answers the call for more research on the transition of complex systems at the edge of business and environment (e.g., Levy and Liechtenstein, 2012). The author validates the results of a qualitative content analysis in a qualitative comparative analysis (QCA) and the study therefore contributes to literature on complex innovation management, thereby extending the urban innovation research field and CAS theory in the ecosystem context. Furthermore, this study amplifies the application of qualitative comparative analyses in innovation management literature.

The next section provides a structured overview of urban innovation literature and explains the urban innovation phenomenon and its potential barriers and drivers from a CAS perspective. Following this, the author presents the data source and the methodologies. The section thereafter explains the results of the qualitative content analysis

and the results of a fuzzy-set approach. The last section contains the discussion and the conclusion.

## **Conceptual framework**

### **Introducing urban innovations as a stand-alone innovation type**

Despite urban innovations' increasing social, economic, and ecologic relevance, the term is not consistently used. While several similar terms are used to describe the phenomenon 'urban innovation,' such as urban development, sustainable development, and urban transformation (e.g., Joss, 2015), the term is used in different contexts. The aim of this paper is therefore to create a unified understanding of the term 'urban innovation' that is based on a broad literature review, and to validate this understanding by means of the study's results.

Recent research on urban innovation has been published mainly in public governance and urban planning literature. Appendix 1 provides an overview of the relevant urban innovation literature. The term urban innovation is used in three different ways: First, urban innovation is the outcome of innovation activities in a city, often represented by the sum of new products, processes, and services in an urban ecosystem and the number of patent applications in a city (e.g., Caragliu et al., 2016; Ning et al., 2016). The urban ecosystem is regarded as a framework that enables the local individuals and organizations to innovate by, for example, establishing communication and telecommunication infrastructures (Athey et al., 2008), as well as knowledge networks (Simmie, 2003). A city can also establish a competitive and challenging environment by means of its governance and policies (Caragliu et al., 2016; Caragliu and Del Bo, 2019).

Second, the urban space builds an urban innovation ecosystem in which stakeholders cooperate to innovate, for example, new products and services (Zygiaris, 2013; Sarma and Sunny, 2017). This line of research focuses on the urban innovation ecosystem's description, its evolution, and design, which result in high innovation rates like a large number of patent applications (e.g., Verwijnen, 1998; Kastalli and Neely, 2013). These ecosystems differ from traditional ecosystems in that, for example, the city ecosystem's perspective is systemic and does not assign clear responsibilities, as it does not focus on a single firm (e.g., Moore, 2006; Peltoniemi and Vuori, 2004).

Third, urban innovation refers to any kind of urban restructuring, like the implementation of new governance and communication channels and urban districts' renovation or restructuring. The urban is therefore the objective of innovation activities (Yigitcanlar, 2009; Mieg, 2012). This third definition of urban innovation fits urban transformation's objective best and is used in this article to describe innovation alternatives that enable a city's sustainable transformation. In this context, several studies discuss how to measure a city's innovativeness. For example, Dente and Coletti (2011) suggest four dimensions on which a city must score high to reach a high degree of innovativeness. Other studies show that the transition toward a smart city is only possible with technological, managerial, organizational, and policy innovations (Nam and Pardo, 2011; Nilssen, 2019). For example, one of the analyzed urban innovation projects in this study developed innovation alternatives in different innovation fields: First, the project team suggested innovation alternatives to energetically renew existing buildings by the use of renewable energies (e.g., photovoltaic system). Second, it planned stakeholder addressing and involvement and defined a long-term contact person in the district. To address the stakeholders, the project team initiated several smaller and exemplary projects. For example, the team supported an exemplary renovation (window replacement and insulation in an apartment) and an exemplary installation of a photovoltaic system. Third and final, it developed an integrated energy concept for a public schoolhouse (e.g., combination of renewable energies and information technology for the schoolhouse's heating). Another one of the analyzed projects developed innovation alternatives in a low-income district and thus focused on the increase of the district's attractiveness. The project team initiated among others the installation of a public Wi-Fi network in the district and established an office in the district that serves as a meeting point for the residents. These examples emphasize urban innovations' complexity and the high relevance of different stakeholder groups in the urban ecosystem. Thus, it is conceivable that urban innovations require close interaction with stakeholders in the urban ecosystem, because they could face obduracy and resistance to change. It is therefore crucial to anticipate and overcome this innovation resistance (e.g., Hommels, 2010; Arnaboldi and Spiller, 2011).

### **The urban ecosystem as a complex adaptive system**

Complexity theory in general describes the underlying mechanisms in systems that are made up of many stakeholders, like organizations that have many interactions and thus

constantly evolve and unfold over time (e.g., Simon, 1996; Arthur, 1999). The interactions of these stakeholders in a wider (eco)system are referred to as CAS (Anderson, 1999; Boisot and Child, 1999; Levin, 2003; McCarthy, 2003). Innovation management literature uses this CAS perspective to describe national innovation systems (e.g., Katz, 2006), new product development (e.g., McCarthy et al., 2006), and innovation development in ecosystems (e.g., Anderson et al., 2012; Roundy et al., 2018), because this perspective supports an understanding of how seemingly unpredictable patterns, behaviors, and structures result in novel outputs. In particular, this perspective explains knowledge flows between stakeholder groups, and thereby reduces the uncertainty inherent in innovation development (Allen, 2001). However, CAS theory emphasizes that innovation processes need adaptability to be capable of, for example, producing incremental and radical innovations, because the different degrees of innovativeness require different levels of interaction intensities (McCarthy et al., 2006). This leaves room for urban innovations to be interpreted as CAS from two perspectives. Both the urban ecosystem as a system in which innovations are developed (e.g., Jucevičius and Grumadaitė, 2014; Karakiewicz, 2016) and the urban innovation development process (i.e., generating innovation alternatives for innovative urban restructuring) are CAS (e.g., Carlisle and McMillan, 2006). Thus, the aim of this study is to shed light on the underlying mechanisms in urban innovation development in urban ecosystems from a CAS perspective.

CAS are characterized by four properties (Anderson, 1999; Palmberg, 2009; Berger and Kuckertz, 2016). First, CAS are composed of agents with schemata. This means that the stakeholders in the system behave according to their specific rules. The various stakeholders in the urban ecosystem have different organizational backgrounds, for example public or private (e.g., Kastalli and Neely, 2013). Consequently, the stakeholders have different organizational routines, and formalization and communication processes, which must be merged for urban innovation development. Second, stakeholders are partly connected to one another in self-organizing networks through, for example, feedback loops (e.g., Rogers et al., 2005). In urban ecosystems, stakeholders may be connected through customer-supplier relationships (e.g., energy utilities, housing companies, and residents), other urban development projects that focus on social activities, and neighborhood associations. Third, the system coevolves to the edge of chaos, since stakeholders' evolution depends on the decisions and behavioral rules of other stakeholders in the system. Because stakeholders react to one another in, for example, processes of emergence and

feedback, the urban ecosystem is self-organizing (Reiman et al., 2015). Fourth, CAS recombine and evolve by themselves over time, since stakeholders leave and enter the systems.

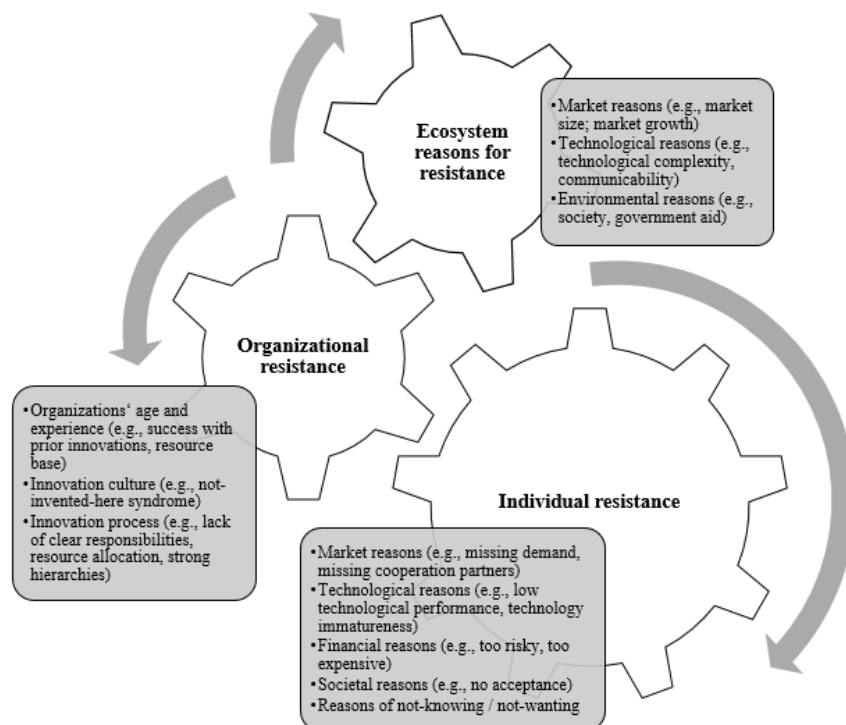
In urban ecosystems the development of innovations is more challenging than that of product, service, and process innovations in organizations, as the ecosystem strengthens the complexity of the different innovation types. Furthermore, urban transition requires all of the aforesaid innovation types to take the urban ecosystem's future ecological needs into account, in addition to relying on more complex and systemic innovations like sustainable and environmental innovations (e.g., Iñigo and Albareda, 2016; Karakiewicz, 2016; Nair et al., 2016). These innovation types rely even more on tacit knowledge and need to be designed more emergently, interactively, and dynamically, than for example service innovations (Gallouj and Weinstein, 1997; Miles, 2008). These so-called eco-innovations are new products and processes, and, although they provide customer and business value, they have a significantly decreased environmental impact (Fussler, 1996; Schiederig et al., 2012; Karakaya et al., 2014) and they emphasize the role of public institutions in the ecosystem. For example, the use of electric powered vehicles requires the collaboration of residents, energy utilities, contactors, car manufacturers, planning offices, the means of transportation (cars), charging stations, information technology, and other entities, as well as the regulatory guidance of the local government (e.g., Joss, 2015).

### **Strategies to encourage urban transformation by means of urban innovation**

Individuals, organizations, and ecosystems can be sources of resistance (e.g., Nijssen et al., 2005; D'Este et al., 2012; see Figure 1). Urban transformation requires extensive changes at all three levels. In the urban ecosystem, stakeholders experienced a process of institutionalization that, over the years, has provided them with increased legitimacy, available resources, and ecosystem-specific capabilities (Meyer and Rowan, 1977; Scott, 1987; Landry, 2012). Consequently, these stakeholders have little motivation to adapt to change. Nevertheless, by drawing on institutional theory, a process of deinstitutionalization can be encouraged for functional, political, and social reasons, such as counteracting climate change and fostering sustainability in urban innovation initiatives (Dacin et al., 2002). Regulatory (rewards and sanctions) and normative (values and norms) pressure foster environmental innovations (Berrone et al., 2013), but normative pressure and

inducement (incentives for changed behavior) are more promising, regarding rapid change with little resistance, than regulatory pressure (DiMaggio and Powell, 1983).

Resistance to innovations, which are new and unknown, is a well-researched phenomenon (e.g., Schumpeter, 1934; March and Simon, 1958). Individuals often have a deep-rooted way of thinking and interacting, for example by not believing in new technologies' technical feasibility as a matter of principle (Szmigin and Foxall, 1998; Chandy and Tellis, 1998). Organizations' strategic orientation, culture, and established processes, and ecosystems' uncertain profitability can hamper new product and service development (Chen et al., 2012). This interaction of individuals and organizations in an ecosystem is an additional source of resistance (e.g., Talke and Hultink, 2010), especially when the stakeholders adopt a negative attitude toward the innovation (Desai, 2018). The urban ecosystem faces further city-specific resistance: Technologies are embedded in sociotechnical systems that are highly path-dependent and thus hard to replace. Furthermore, due to the far-reaching ecosystem, individual goals can be contrary to political and social priorities (Hommels, 2010; Landry, 2012).



**Figure 1. Innovation resistance within and outside an organization; own illustration based on Hauschildt, 1999 and Hadjimanolis, 2003**

Change management is the discipline that helps overcome innovation resistance. Lewin (1947) suggests three steps to encourage change: unfreeze, move, and freeze again. Change management literature presents various models, the application of which varies depending on the change complexity (e.g., Kotter, 1996; Washington and Ventresca, 2004; By, 2005; Appelbaum et al., 2012). MacIntosh and MacLean (1999) emphasize that managing at the level of deep structure supports self-organizing processes in CAS. Therefore, an in-depth analysis of the agents' schemata (Anderson, 1999) is the key to successful unfreezing, while positive and negative feedback loops are essential during the freezing phase. Furthermore, the literature emphasizes several innovation drivers that foster the effective moving from one state to another. For example, incentivizing investments in innovation development and supporting collaborations within the CAS may increase their innovation performance (e.g., Ponsiglione et al., 2018). Overall, innovation diffusion is successful in CAS when initial groups push the diffusion and the underlying network structures are tight (Choi et al., 2010).

## **Methods**

Qualitative and explorative research supports our understanding of new research fields, theory-building, and theory-elaboration (Edmondson and McManus, 2007; Arino et al., 2016; Fisher and Anguinis, 2017). Urban transformation is a highly relevant but under-researched phenomenon in innovation management literature (e.g., Koop and Leuwven, 2017). Consequently, this study is based on an explorative approach that investigates several urban innovation initiatives in Germany. Because qualitative data is often based on soft and fuzzy interview data, methodological rigor is important (e.g., Goffin et al., 2019). This paper thus follows the evaluation guidelines suggested by Goffin et al. (2019) and combines two methods, namely qualitative content analysis and QCA, to assess the underlying mechanisms in urban innovation. Thereby, the results of the qualitative content analysis serve as the data base for a QCA. Furthermore, this study builds on multiple sources of data (semi-structured interviews at two points in time, written documents, and online desk research).

## Data sample

The author conducted 20 semi-structured interviews at two points in time with experts from seven urban innovation initiatives in Germany (multiple experts per initiative). Thereby, an iterative process of data analysis was used. The data were analyzed as they were collected (Eisenhardt, 1989) and more data were collected until a state of ‘theoretical confidence’ was achieved. The urban innovation initiatives were aimed at developing and implementing innovation alternatives to transform well-established city districts into low-carbon and energy-efficient green districts like the French initiative *ÉcoQuartier* (Joss, 2015). The initiatives were publicly funded from the same funding program, which means that their goals and the list of potential innovation alternatives for all the districts were similar. It was therefore possible to investigate urban innovation independently of the kind of innovation project. At the point of data collection, about 600 of these initiatives were funded in Germany (Bundesministeriums des Innern, für Bau und Heimat, 2018). The data sample included projects from urban and local areas and represented all city sizes in the north of Germany. To ensure an in-depth investigation of the urban innovation projects, a small sample size was used.

The experts, such as architects, city planners, and employees of energy suppliers and urban administrations (community and city administration), were part of a project team developing innovation alternatives for sustainable urban development. The experts summarized these innovation alternatives in a written document, embodying their concept for implementation. Later, this project team initiated the implementation of urban innovations that allowed the involvement of other stakeholder groups, such as private owners, inhabitants, energy suppliers, and planning offices. Only public institutions, like an urban administration, could apply for public funding and were thus the organizations in charge of coordinating the development and implementation. The data sample included experts from all the urban innovation initiatives’ stages of development. As the project team often consists of more than one organization, the author invited all the project team members for interviews. Thus, in 2016, multiple expert interviews were conducted per project. Partly, the same experts were responsible for multiple projects so that one interview contains information on various projects. The interviews lasted between 30 and 60 minutes, with an average duration of 40 minutes.

Fourteen of the 20 expert interviews were conducted in 2016, where two of the projects were in the phase of innovation development, and five projects in innovation



implementation. Innovation development and implementation management must be funded separately and projects for which innovation alternatives have been developed do not necessarily receive funding for implementation management. In addition, in 2019, all the experts were invited to a follow-up interview. The author conducted interviews with six of them, representing six of the seven urban innovation projects in this study. The seventh urban innovation project was terminated after the innovation development phase and did not reach implementation, which meant that a follow-up interview was not possible. The other six projects were completed, independently of their actual implementation success. Again, the interviews lasted between 30 and 60 minutes, with an average duration of 35 minutes. In addition, the author used information from the urban innovation projects' concept to investigate their scope and analyzed the projects' homepage and newspaper articles to validate the experts' information on, for example, the implementation success of the projects. Table 1 provides an overview of the sample characteristics.

**Table 1. Sample characteristics of the urban innovation projects in the qualitative content analysis**

Type of participating organization	Number 2016	Number 2019	Interviewed organizations per project	Number 2016	Number 2019	City size	Number 2016	Number 2019
Architects/ engineers/ planners	2	1	One organization	2	5	Rural area (<5,000 inhabitants)	1	1
Community/city	4	1	Two organizations	1	1	Mid-town (5,001–99,999 inhabitants)	3	2
Energy agency/consultants	6	3	Three organizations	2	-	Large city (>100,000 inhabitants)	3	3
Energy utility	2	1	Four organizations	2	-			

Note: Number refers to the number of interviews with experts from the urban innovation experts (n=14 in 2016; n=6 in 2019) number of urban innovation projects n=7

Furthermore, to extend the sample size of the QCA to 33, the author conducted short telephone interviews with an additional 26 urban innovation project teams. Therefore, the project teams provided information on whether they implemented the innovation alternatives they had previously developed, and on the innovation drivers that were

identified in the qualitative content analysis. Table 2 shows the sample characteristics of the additional 26 urban innovation projects.

**Table 2. Sample characteristics of the urban innovation projects in the QCA**

<b>Size of the regional ecosystem (based on the city's size)</b>	<b>Number</b>	<b>Percent</b>	<b>Size of the urban innovation project (based on the city districts' inhabitants)</b>	<b>Number</b>	<b>Percent</b>
Rural community (<5,000 inhabitants)	2	7.7%	<1,000	7	26.9%
Small town (5,001-20,000 inhabitants)	7	26.9%	<2,500	10	38.5%
Medium-sized town (20,001-100,000 inhabitants)	11	42.3%	<5,000	3	11.5%
Large city (>101,001 inhabitants)	6	23.1%	≥5,000	6	23.1%

<b>Size of the project team</b>	<b>Number</b>	<b>Percent</b>
2 team members	5	19.2%
3 team members	9	34.6%
4 team members	5	19.2%
5 team members	2	7.7%
6 team members	1	3.9%
≥ 7 team members	4	15.4%

n=26 urban innovation projects

### Qualitative content analysis – Coding and data analysis

In 2016, the author contacted the experts and collected data by means of personal or telephonic semi-structured, in-depth interviews. The interview guide was based on a literature review of urban development, innovation resistance, and ecosystems. The interviews were later transcribed and then subjected to a qualitative content analysis procedure (Gioia and Chittipeddi, 1991; Gioia et al., 2012) using MAXQDA 2018 (VERBI Software, 2017). Data analysis was conducted as follows. The initial and exploratory first-order analysis (following an ‘open coding’ principle (Corbin and Strauss, 2015)) led to the identification of many codes, which were labeled using respondent-centric terms. Based on the literature review, the author then deductively developed a reference guide comprising the ten main categories (e.g., urban innovation definition, innovation resistance, innovation drivers). The second-order categories were then obtained through axial coding (Corbin and Strauss, 2015). This helped reduce the initial codes to a smaller number, and researcher-centric concepts either drawn from the theory, the research questions, or emerging from the data were identified. Subsequently, the author refined the categories by adding subcategories (e.g., repeated stakeholder contact and early stakeholder involvement as two

innovation drivers). As a result, each main category contains an average of ten codes (minimum four codes, maximum 15 codes per main category). Finally, the author analyzed and interpreted the main and subcategories to answer the first two research questions. This reduced the number of relevant main categories to three (urban innovation process, innovation barriers, and innovation drivers), the number of relevant subcategories to 35, and the number of relevant coded text segments to 846. Table 3 defines the resulting innovation barriers, gives proof quotes, explains the barriers based on CAS and institutional theory, and allocates the barrier to the kind of resistance (see Figure 1). Table 4 provides an overview of the innovation drivers (definition and proof quotes) and matches the innovation drivers with the innovation barriers from Table 3. In order to answer the third research question, the resulting innovation drivers were used as conditions in the ensuing QCA. Two individual coders coded the interviews to ensure inter-coder reliability. Furthermore, coding was repeated twice to ensure the validity of the codes. The coding scheme contained 99 different codes, which the coders assigned 1560 times to a text segment. On average, each interview contains 111 coded text segments. In 2019, the author contacted the experts again and, by means of personal and telephonic, in-depth interviews, collected data on the implementation status, barriers, and innovation drivers. This analysis followed the same procedure as described above (Gioia and Chittipeddi, 1991; Gioia et al., 2012; Corbin and Strauss, 2015). The results of the analysis validate the barriers and innovation drivers previously identified, and yield information on which of the proposed innovation alternatives were implemented successfully.

**Table 3. Data table showing the revealed innovation barriers**

Construct	Complex stakeholder structure	Low profitability of innovation alternatives	Missing implementation partners	Low stakeholder responsiveness	Unclear governmental aids	Inappropriate degree of innovativeness	Missing technological feasibility	Missing qualification of implementation project team
<b>Definition</b>	Describes barriers resulting from complex and interwoven stakeholder networks like stakeholder owner structures and age	Describes all barriers related to a (perceived) low profitability of the innovation alternatives	Describes missing implementation partners and their problems	Describes missing stakeholder responsiveness and engagement	Describes all barriers that are related to governmental aids for urban innovation	Describes that too high levels of innovativeness may hamper urban innovation implementation	Describes all barriers from the district structure that may hamper the implementation of innovative technological solutions	Describes all barriers that refer to the missing qualification of the project team that develops and implements urban innovations
<b>Proof quote(s)</b>	<p><i>There are many older homeowners in the district. These people do not know who will inherit their houses and they are thus not willing to invest in innovation alternatives, because they do not perceive profit.</i></p> <p><i>In a district with community associations with about 200 members, it's just not possible to agree on one innovation alternative.</i></p>	<p><i>The heating prices of the developed innovation alternatives are much higher than the prices of oil. Oil heating is ways too cheap.</i></p> <p><i>People won't change to more innovative solutions when they adopted a new technology in the last two years. In their opinion, a more innovative technology will not pay off.</i></p>	<p><i>We (the project team) developed innovation alternatives, but we can't continue with the innovation implementation, because no one is willing to invest in the innovation alternatives. For example, the energy supplier is not interested in supporting innovative system innovations.</i></p>	<p><i>Stakeholder motivation is both the most crucial in urban innovation and the most challenging.</i></p> <p><i>We (the project team) try to organize our events as catchy as possible, but in relation to the total number of inhabitants in the district, the number of participants is too low.</i></p>	<p><i>Stakeholders often don't know that public funding is possible. And if they know that this is possible, the conditions that they must fulfill to apply for funding are very confusing and complicated.</i></p>	<p><i>We (the project team) will always find some early adopters of innovative technologies, but the main part of the stakeholders slowly adopts innovations. If we offer them highly innovative solutions, they won't implement anything. They prefer solutions that are more convenient.</i></p> <p><i>The technological feasibility of highly innovative solutions is often too uncertain for implementation [...].</i></p>	<p><i>We as a project team have a strong interest in the development and implementation of innovative technologies like an ice storage. We have an implementation partner, but it seems as if we can not implement it because the district lacks space.</i></p> <p><i>We (the project team) can't install wind energy in the district.</i></p>	<p><i>A project team has to do more than just the design of information material. It needs to have knowledge on urban planning, engineering, climate protection, and business administration. Some project teams do not have these characteristics.</i></p>
<b>Number of codes</b>	37	36	19	16	13	12	11	10
<b>Explanation by extant literature (CAS and institutional theory)</b>	Stakeholders in the whole urban ecosystem (the CAS) behave based on their own schemata and have a high degree of institutionalization	Technological and market reasons in the urban ecosystem do not promote individual stakeholders' behavioral changes	Organizational stakeholders are not open for innovations and fear risks because of radical changes in their organization and the CAS	Stakeholder are in established and coevolving networks – urban innovation does not affect them individually	Wider ecosystem does not motivate and incentivize the change of individual stakeholders in the CAS	Innovativeness and implementation may contradict each other, thereby not supporting individual stakeholder change	Technological feasibility not given for implementation in the CAS	Project team as temporary organization has not the required and diverse resources required in the CAS
<b>Kind of resistance</b>	Ecosystem resistance	Individual resistance	Organizational resistance	Individual resistance	Individual resistance	Individual resistance	Ecosystem resistance	Organizational resistance

**Table 3. Data table showing the revealed innovation barriers (continued)**

<b>Construct</b>	Long time horizon of implementation	Unsupportive stakeholder attitude	Time lags in implementation	Information asymmetries in implementation	Imprecise data collection	Bad regulatory conditions	Involvement of multinational organizations
<b>Definition</b>	Describes all barriers that are related to the long implementation horizon of urban innovations	Describes all barriers that are related to skeptical stakeholders that do not see the need for urban innovation	Describes all barriers that result from delays in the implementation phase	Describes that unequally distributed information between stakeholders and project team hampers innovation implementation	Describes barriers caused by careless data collection in the early innovation development	Describes all barriers that arise because of the regulatory framework in Germany	Describes problems because of the involvement of multinational organizations in urban innovation
<b>Proof quote(s)</b>	<i>It is not possible to implement system innovations like local heat supply systems and smart city solutions in two or three years. And because the stakeholders know that, they fear the investments in such innovations.</i>	<i>The stakeholders are just not interested. It is even worse. They do not recognize the need for urban transformation and are skeptical. But we (the project team) have the same problem with all the stakeholders, representing residents, energy utilities, and real estate companies. They do not want to change.</i>	<i>We (the project team) started the implementation of a local heating infrastructure [...], and because of slight delays in the early implementation, we nearly lost one of our implementation partners. If you fiddle around, stakeholders lose their motivation.</i>	<i>We as a project team had wrong information during innovation development, because of complex stakeholder structures. We did not know which stakeholder had the required information and estimated for example, energy consumption data..</i>	<i>It is inevitable to have the real energy consumption data of the houses in the district to calculate innovation alternatives, because if the data are not precise, the innovation alternatives rely on wrong assumptions.</i>	<i>Germany has for everything regulatory conditions and laws. This hampers the development and implementation of innovations in the public space like in urban districts, because we (the project team) always have to ensure that we are allowed to implement the innovation alternatives from a regulatory point of view.</i>	<i>The large and multinational organizations [...] only focus on increasing their profit and are not interested in German urban innovation projects.</i>
<b>Number of codes</b>	8	8	7	6	6	4	2
<b>Explanation by extant literature (CAS and institutional theory)</b>	CAS change takes time, because of the large number of stakeholders	Individual stakeholders in the CAS do not recognize the need for behavioral changes	Organizations have problems with the implementation in stakeholder networks	Complexity hampers CAS' stakeholders information gathering	Stakeholders are not willing to offer information to the urban innovation project team	Regulatory framework does not allow the CAS to change	Organizations are not open for system innovations in CAS
<b>Kind of resistance</b>	Ecosystem resistance	Individual resistance	Organizational resistance	Organizational resistance	Individual resistance	Ecosystem resistance	Organizational resistance

**Table 4. Data table showing the revealed innovation drivers**

<b>Construct</b>	Use multipliers and synergies from key stakeholders	Repeated stakeholder contact	Strong support by implementation partners	Detailed feasibility checks and profitability calculations	Be contactable by phone/mail and in established local contact points	Team composition	Generate synergies between innovation alternatives	Early involvement of stakeholders like implementation partners
<b>Definition</b>	Describes how the project team identifies and uses synergies from multipliers and key stakeholders in the urban district	Describes that repeated stakeholder contact ensures urban innovation implementation by emphasizing urban innovations' importance	Describes implementation partners and their implementation willingness as decisive for urban innovation implementation	Describes the importance of detailed feasibility checks and calculations for implementation	Describes the importance of being contactable by phone/mail and in an established local contact point	Describes the required project team characteristics for urban innovation implementation	Describes how to generate synergies to increase stakeholder benefits and urban innovation implementation	Describes that early stakeholder involvement eases urban innovation implementation
<b>Proof quote(s)</b>	<i>If we (the project team) work together with multipliers, we recognize a snowball effect. Multipliers spread the positive aspects of urban innovation in the district and encourage other stakeholders to implement.</i>	<i>It is important that urban innovations stay in the mind of the stakeholders. It is not enough to have talked to them once. Stakeholders forget fast and in addition, they do not have the feeling of being important. Repeated contact ensures stakeholder loyalty.</i>	<i>The stakeholders who will be responsible for investment in the system innovations should be involved as early as possible.</i>  <i>In the project, the energy utility was leading the implementation of heating concept, because it recognized early the business potential and the potential to build up strong stakeholder relationships.</i>	<i>The project team has to ensure that the innovation alternatives are profitable. This can be done by detailed checks of the technological feasibility of innovation alternatives and considering different scenarios.</i>	<i>Being present in the district is inevitable.</i>  <i>It is one of the key success factors that the project team is known in the district and that the project team knows the stakeholder requirements and stakeholder networks in the district.</i>  <i>Stakeholders must have a contact person, which they can call when they have questions.</i>	<i>It is necessary to have a diverse set of professional knowledge and functional backgrounds in the project team. If a project team wants to implement photovoltaics, they need to have an expert for that. However, knowing the stakeholders and knowing how to talk to them might be more important.</i>	<i>If a district needs a road rehabilitation, why should a project team not think about changing the district's heating supply at the same time? If the team works on a renewed heating supply in the district, why should it not think about establishing fiber optic cable networks for telecommunication and smart city solutions?</i>	<i>We (the project team) involved residents and industry in the district before we developed the innovation alternatives.</i>  <i>We (the project team) talked to all stakeholders very early: the community associations, the real estate companies, the public institutions, and the residents.</i>
<b>Number of codes</b>	31	27	26	22	21	21	19	18
<b>Addressed barriers</b>	Complex stakeholder structure; low stakeholder responsiveness; unsupportive stakeholder attitude	Complex stakeholder structure; low stakeholder responsiveness; unsupportive stakeholder attitude	Low profitability; missing implementation partners	Imprecise data collection; missing technological feasibility	Complex stakeholder structure; information asymmetries in implementation; unsupportive stakeholder attitude	Information asymmetries in implementation; missing qualification of the project team; time lags in implementation	Inappropriate degrees of innovativeness; long time horizon of implementation; unsupportive stakeholder attitude	Imprecise data collection; low stakeholder responsiveness; missing implementation partners

**Table 4. Data table showing the revealed innovation drivers (continued)**

<b>Construct</b>	Attractive design of information events	Transparency and comprehensibility of innovation alternatives	Short implementation time horizon	Use synergies in the district structure like established neighborhoods	(Non-) financial Stakeholder incentives like grants and awards
<b>Definition</b>	Describes possibilities to increase the attractiveness of information events	Describes that transparency and comprehensibility in the development eases implementation	Describes why short implementation horizons encourage urban innovation implementation	Describes which district and stakeholder structures offer synergies for urban innovation implementation	Describes all incentives that encourage stakeholders for urban innovation implementation
<b>Proof quote(s)</b>	<i>It is much easier to reach the stakeholders if we combine two events. Once we organized a circus and addressed climate protection and urban innovation. This worked.</i>	<i>Transparency is very important. The stakeholders have to decide whether they implement an alternative or not based on the innovation development. Thus, the project team has to work as transparent and comprehensible as possible.</i>	<i>It is important that innovation alternatives are implemented directly after the project start, because this demonstrates implementation willingness and readiness.</i>	<i>If one stakeholder in an established neighborhood implements urban innovation alternatives, the other stakeholders in the association will be more willing to implement.</i>	<i>We (the project team) have a small budget to support the implementation of innovative solutions and we see that this encourages stakeholders to implement.</i>  <i>We made a mini-competition. People could win two hours with an energy consultant that checked their houses.</i>
<b>Number of codes</b>	17	10	9	7	6
<b>Addressed barriers</b>	Complex stakeholder structure; low stakeholder responsiveness	Missing implementation partners; missing technological feasibility; unsupportive stakeholder attitude	Time lags in implementation	Complex stakeholder structure; low stakeholder responsiveness; unsupportive stakeholder attitude	Complex stakeholder structure; low stakeholder responsiveness; unsupportive stakeholder attitude

### **Qualitative comparative analysis – Measures and data analysis**

QCA allows cases to be viewed as combinations of causally relevant conditions (Mahoney and Goertz, 2004; Ragin and Fiss, 2008) and is used to analyze complex dependencies in organizational and ecosystem settings (e.g., Woodside, 2013; Ganter and Hecker, 2014; Khedhaouria and Thurik, 2017; Ryan, 2017; Woodside et al., 2018). Therefore, QCA is appropriate to investigate the success factors of urban innovations. It relies on case comparisons, set-theoretic analysis of set-subset relationships, and the application of Boolean algebra to identify combinations that systematically discriminate members of the set which exhibit various levels of outcomes, represented by the implementation success in this study (Ragin, 2000). This study uses a conventional and dichotomous data for the causal conditions, because the analysis of qualitative data only allows evaluating whether a condition is ‘in’ or ‘out’ of a set, and not to which extent a condition is fulfilled and intermediate values (between 0 and 1) for the implementation success (Schulze-Bentrop, 2013). Thus, the study’s results rely on a ‘fuzzy set’ and such ‘fuzzy-set’ QCA (fsQCA) is suitable to investigate small sample sizes (Fiss, 2007; Rihoux and Ragin, 2009), in combination with a high number of variables (Ragin, 2018), especially considering that this study’s results rely on only 33 urban innovation projects.

The outcome in this study is the actual *implementation success* and was dummy-coded for each urban innovation project (0=no implementation; 1=at least two-thirds of the developed innovation alternatives and/or alternatives that better fit the district’s structure were implemented). It was evaluated based on the 2019 follow-up, telephone interviews. Therefore, the experts were asked which of the previously developed innovation alternatives were implemented in the urban district. Their statements were validated based on an online search of the urban innovation project’s homepage (if available) and newspaper articles on the project’s progress. Additionally, three independent researchers validated the implementation success as successful or not based on the interview protocols to consider the fuzziness of urban innovation implementation and to ensure the intercoder-reliability. If projects did not implement the previously developed alternatives, but rather more feasible alternatives, those projects were also evaluated as successful, due to the urban innovations’ complex and adaptive character. The mean of the three researchers’ evaluation was used as the implementation success in the QCA.

The identified *innovation drivers* (see Table 4) are the conditions in the QCA. The coding and data analysis procedure in the qualitative content analysis indicated 13 general



but valid innovation drivers. After the analysis, the author checked transcripts, written concepts, homepages, and newspaper articles, to determine whether the experts used these drivers as instruments to achieve implementation. Based on this, the innovation drivers were classified 0 ('not considered in the project') or 1 ('considered in the project'). Furthermore, three innovation drivers were added. First, since 'being contactable' is an innovation driver, it is relevant whether an urban innovation project has an *established contact point*, such as a district office. Second, *generating synergies from other urban development programs* was included in the QCA, because the qualitative content analysis showed that other urban development programs were essential for the initiation of the urban innovation projects investigated for the purposes this study. Third, *implementation management* is deemed to influence the implementation process, because a structured process with clear responsibilities in general fosters project success (Schultz et al., 2019a; Schultz et al., 2019b). Implementation management was classified as successful when the project team, which coordinated and organized the implementation of the previously developed innovation alternatives, was funded for a two to five-year period. Information on whether funding was granted or not was obtained from the funding agency's report, available in the public domain (Investitionsbank Schleswig-Holstein, 2019). To ensure the quality of the analysis, the author checked to ensure that the cases investigated included a mix of cases with positive and negative outcomes, cross-condition diversity, and sufficient variation for each condition. Consequently, innovation drivers that were used in more than five of the seven urban innovation projects in the qualitative content analysis were excluded from the comparative analysis (Rihoux and De Meur, 2009), and were not covered during the telephone interviews. Therefore, eight innovation drivers were tested as success factors in the subsequent fsQCA with a total sample size of 33 urban innovation projects. Table 5 shows their respective means, standard deviations, and correlations.

**Table 5. Mean, standard deviation, and correlations**

Condition	Mean	S.D.	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. Stakeholder incentives	.55	.51	(-)								
2. Established contact point in the district	.52	.51	-.16	(-)							
3. Feasibility checks	.83	.38	.32	.11	(-)						
4. Implementation partner	.56	.50	-.20	-.25	-.20	(-)					
5. Synergies in district structure	.53	.51	.06	-.06	.35	.09	(-)				
6. Transparency and comprehensibility	.79	.42	.42*	.09	.76**	-.01	.41*	(-)			
7. Short implementation time horizon	.61	.50	.08	-.11	.39*	-.03	.33	.45*	(-)		
8. Implementation management	.64	.49	.32	.02	.44*	-.03	.18	.38*	.38*	(-)	
9. Implementation success	.39	.39	.40*	-.06	.25	-.11	.18	.27	.15	.12	(-)

S.D., standard deviation.  
 \* p < .05, \*\* p < .01, \*\*\* p < .001 (two-tailed).  
 n=33

To carry out the analysis the ‘fuzzy-set/qualitative comparative analysis 3.0’ software, which is also suitable for fsQCA, was used (Ragin and Davey, 2016; Ragin, 2018). First, after transforming data into sets, the process creates a data matrix called a ‘truth table’ with  $2^k$  rows, where  $k$  is the number of causal conditions, namely the number of innovation drivers. In this study, the truth table has  $2^8=256$  rows. Second, the number of rows are reduced by the acceptable consistency level for the solution (minimum recommended threshold of 0.75 (Ragin and Fiss, 2008)) and the minimum number of cases required to consider a solution (Ragin, 2006). Third, an algorithm based on Boolean algebra logically reduces the truth table rows to simplified combinations. The truth table algorithm provides parsimonious, intermediate, and complex solutions based on both easy and difficult counterfactuals (Ragin, 2018). A parsimonious solution includes all the simplifying assumptions, regardless whether they are based on easy or difficult counterfactuals, whereas an intermediate solution includes only those simplifying assumptions based on easy counterfactuals. The parsimonious solution thus delivers only the core conditions (i.e., those with the highest strength of evidence in relation to the outcome suggested in Fiss (2011)), while the intermediate solution delivers core and peripheral conditions. A complex solution includes neither easy nor difficult counterfactuals and is, as proposed in previous

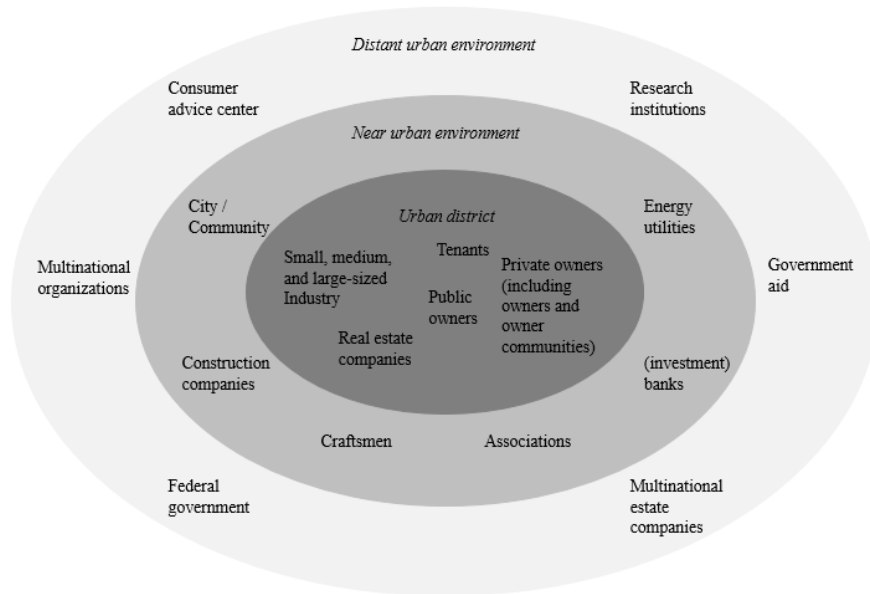
research, disregarded in this study (Fiss, 2011; Khedhaouria and Thurik, 2017; Woodside et al., 2018).

## **Results**

The analysis provided an overview of (i) the urban innovation process with the relevant stakeholder groups for involvement, (ii) the barriers that had arisen during the implementation, and (iii) the success factors that foster urban innovation implementation based on fsQCA.

### **Urban innovation process**

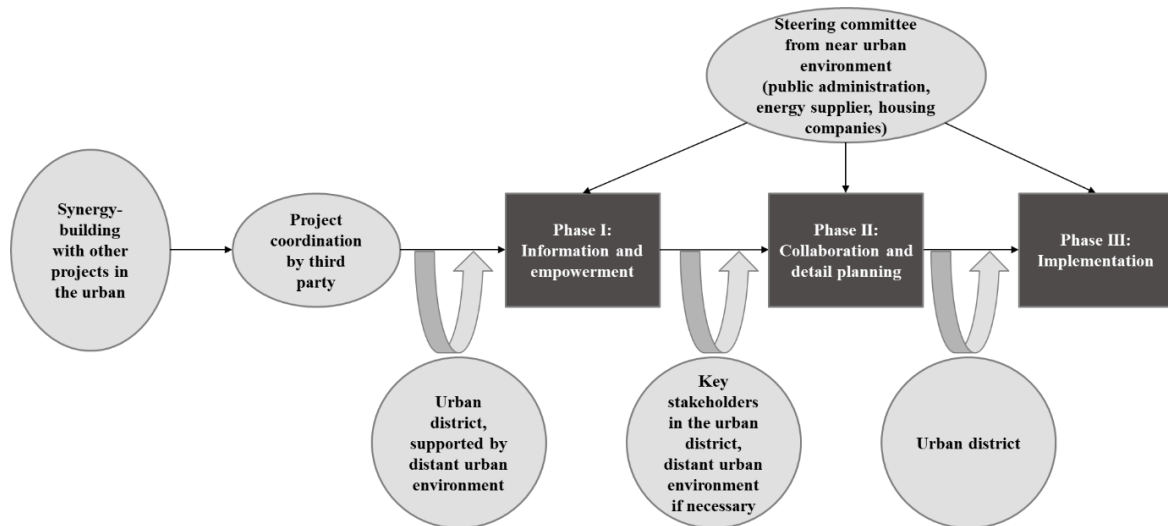
The innovation development and implementation process was analyzed from the perspective of CAS. Figure 2 depicts the resulting urban ecosystem, including those stakeholders who are dependent on their closeness to the implementation of urban innovation alternatives. The core includes all the stakeholders directly affected by urban innovation development since they are, among others, located in the district as the owners of buildings. The near urban environment contains all stakeholders relevant for the implementation, while the distant urban environment includes all the stakeholder groups who can be consulted if necessary. The key stakeholders in the urban district may not be able to implement urban innovations without the support of the urban environment. As a result the different stakeholders have to collaborate across the ecosystem's borders to achieve implementation, an action which justifies the view of the urban ecosystem as a type of CAS.



**Figure 2. Actors in the urban innovation ecosystem**

Figure 3 provides a schematic description of the urban innovation implementation process. Accordingly, the seven urban innovation projects' processes were analyzed in-depth and subsequently compared. This implementation process comprises three phases aligned with change management approaches (Lewin, 1947; Kotter, 1996; By, 2005; Appelbaum et al., 2012). First, the information and empowerment phase ('unfreezing') focuses on stakeholder identification, information, and engagement in the urban district. Second, the collaboration and detail planning phase ('moving') requires close collaboration among key stakeholders, implementation partners in the near environment, and stakeholders in the distant environment who have the knowledge to initiate urban transformation. Third, the successful implementation of innovation alternatives completes the transformation ('freezing'). In accordance with the definition of CAS (e.g., Anderson, 1999; Reiman et al., 2015; Berger and Kuckertz, 2016; Roundy et al., 2018), stakeholders' behavioral rules and their networks determine the intensity of feedback loops during the process phases. For example, stakeholders like energy suppliers who do not support the urban innovation project but who have a strong influence on its implementation, may force the project team and the steering committee to identify alternatives. The whole system thus coevolves in dependence with the stakeholders' attitude toward the urban innovation project and their influence on its implementation. Additionally, the stakeholders in the

urban district are connected, for example through established neighborhood networks and associations that interact independently of the urban innovation project. This may change stakeholders' willingness to implement the urban innovations. Furthermore, stakeholders who leave and enter, such as changing house owners (real estate companies, private owners), hamper stakeholder engagement and thus increase process complexity.



**Figure 3. Urban innovation implementation process**

### Urban innovation barriers and drivers

The analysis of the qualitative data reveals several urban innovation barriers. These barriers are grouped, based on the kind of stakeholders affected by a particular barrier (see Figure 1 and Table 3) and on the locus of resistance which hampers the implementation process (urban district, near and distant urban environment). Figure 4 summarizes these barriers, with size representing the frequency of the respective barriers in the content analysis. Based on the number of barriers and their frequency, the most important barriers are those in the urban district. The figure also illustrates that the importance of barriers decreases with the distance from the ecosystem core. This is understandable as urban innovation implementation relies on the acceptance and willingness of key stakeholders in the urban district. Consequently, the stakeholders' structure, their attitude towards the transformation, and their responsiveness present barriers. An expert stated that stakeholders do not believe that climate change and its consequences are of personal importance to them:

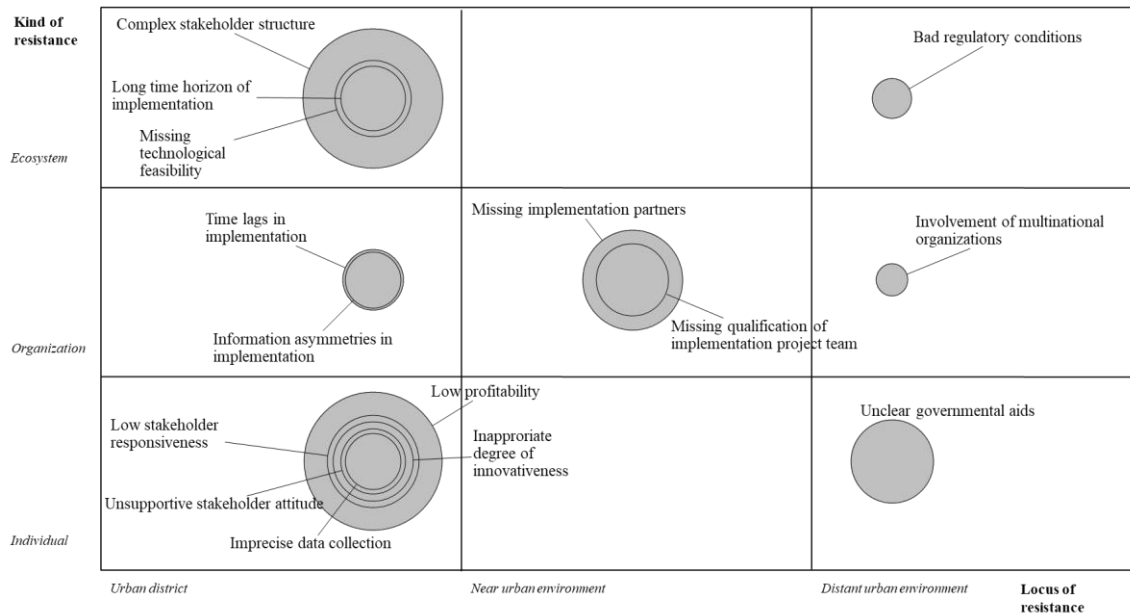
*Stakeholders believe that resources are becoming increasingly expensive, [...] but, as a topic, carbon emissions do not bother them. [...] That is why they don't realize that action has to be taken now, even though this will have no economic effect. No homo oeconomicus reacts in such a way. He reacts [...] for completely different reasons.*

Organizational stakeholders are located in the near environment who support the implementation with, for example, investments, information, and management (see Figure 2). Thus, individual and ecosystem resistance cannot emerge, because the respective stakeholder groups are not part of the near urban environment. These third-party organizations are often not willing to implement urban transformation innovation alternatives, among others owing to the uncertain profitability of these alternatives for the stakeholders in the urban district. One of the experts emphasized:

*The concept has been developed, the potential has been estimated, [...], but the next steps of 'who does what' and who participates are unclear at the moment, and that's why we can't move on to the next step of project implementation. [...] If, for example, municipal utilities were to provide support on the background, this would make a difference with regard to investments, [...], but now it is rather unfavorable.*

The distant environment provides the regulatory framework that cannot be influenced by stakeholders in the urban district and the near environment, and this can hamper urban innovation implementation. Regulatory affairs and unclear governmental funding are other, specific barriers that arise in the distant urban ecosystem, but which hamper implementation in the urban district. An expert confirmed this observation:

*If you see districts with four or five stakeholders that determine the implementation, like four or five housing companies, you implement very easily. [...] But, our steering group is virtually the whole circle of owners. We have to plan with 250 owners for 250 houses, which means speaking to 250 stakeholders. [...] All of this would just be easier if the funding programs were easier to understand and easier to apply for. We would then implement everything a lot faster.*



**Figure 4. Urban innovation implementation barriers. The size reflects the relevance of the barrier in urban innovation implementation**

In summary, the key stakeholders in the urban district, the structure of the district, the kind of innovation alternatives, and the potential implementation partners present the main source of urban innovation resistance. Innovation drivers can thus assist in overcoming these innovation barriers. Thereby, the distant urban environment is not changeable by the project team. The innovation drivers can not assist in overcoming these barriers (see Table 4). Apart from the assessment of the urban structure, stakeholder motivation is important. Individual incentives, like financial grants and public funding, and non-financial incentives, like an award for the most climate-friendly building, need to attract the stakeholders' interest. Furthermore, innovative communication channels and short implementation time horizons support implementation. An expert provided insight on how to draw attention to climate-friendly urban transformation:

*We combined our information events on energy and climate protection with, for example, [...] a manicure. That's how it is: I sell sparkling wine, or I sell wine and floristry. [...] These double products gave us the idea to do something crazy. We once used a camel caravan to motivate energy consulting. The project team obtained a camel and went from door to door with this camel. [...] But sometimes, a climate scorecard is enough for motivation, right? You don't always need a camel, but it may help to draw attention.*

It is necessary to extend stakeholder networks and to establish new ones, using the synergies of other urban initiatives that may not focus directly on reducing carbon emission and increasing energy efficiency. It is even possible to extend urban transformation by

means of social issues and digitalization. For example, by establishing smart city solutions and implementing information technologies, energy efficiency can be promoted. An expert explained the different kinds of synergy effects in urban innovation:

*Urban innovation can create synergy effects and not just between different funding programs. [...] If, for example, someone replaces his roof and also insulates it, more is implemented than was originally planned. [...] But, if you're already implementing innovation alternatives in the urban district, you can simultaneously develop and implement something innovative, like telecommunications and smart applications.*

Further, urban innovation depends strongly on implementation partners. An expert described how his project team developed innovation alternatives:

*The stakeholders in the district had to see that their needs were taken seriously and [...] considered in the development and implementation of innovation alternatives. At the same time, the district had to keep its atmosphere and basically remain the same. [...] We therefore sought personal contact with the residents. It quickly became apparent which stakeholders really wanted to engage. [...] Finding key players who are willing to plan and invest for the long term without short-term and high return expectations is crucial. [...].*

### **Success factors in urban innovation**

The analysis of success factors by fsQCA starts by testing whether any of the eight conditions (see Table 5) and their negotiation are necessary for implementation success. Conventionally, a condition is 'necessary' if its consistency score exceeds the threshold of .90 (Schneider et al., 2010). Table 6 shows that feasibility checks and transparency and comprehensibility in the innovation development process exceed this threshold (both have a consistency of .91), while no condition necessarily needs to be absent for purposes of urban innovation implementation. None of these necessary conditions are trivial, because their coverage rate is essentially higher than zero (Schulze-Bentrop, 2013).



**Table 6. Analysis of the necessary conditions of implementation success**

Causal Condition	Consistency	Coverage
Stakeholder incentives	.74	.58
Established contact point in the district	.54	.45
<b>Feasibility checks</b>	<b>.91</b>	<b>.48</b>
Implementation partner	.51	.40
Synergies in district structure	.60	.47
<b>Transparency and comprehensibility</b>	<b>.91</b>	<b>.48</b>
Short implementation time horizon	.69	.50
Implementation management	.69	.47
~ Stakeholder incentives	.26	.25
~ Established contact point in the district	.46	.41
~ Feasibility checks	.09	.20
~ Implementation partner	.49	.47
~ Synergies in district structure	.40	.39
~ Transparency and comprehensibility	.09	.20
~ Short implementation time horizon	.31	.33
~ Implementation management	.31	.37
~ represents the negotiated causal condition		
Consistency values below .90 do not meet the criteria for necessary conditions, but the discovery of necessary conditions does not abound among QCA studies (Schneider et al., 2010; Schulze-Bentrop, 2013)		
n=33 urban innovation projects		

Table 7 indicates the sufficient conditions of implementation success, based on the intermediate solutions. Nine configurations of conditions result in innovation implementation, exhibiting a high overall solution consistency (threshold  $>.80$ ; Ragin and Fiss, 2008). The overall solution coverage indicates that these causal conditions account for 89% of membership in the solution. Raw and unique coverage assess the empirical importance of each configuration. Raw coverage measures the proportion of memberships in the outcome covered by causal conditions that are assumed to be present in a configuration; unique coverage measures the contribution proportion to the outcome of causal conditions present in a configuration that are not covered by other causal conditions present in the solution (Ragin, 2006). The raw coverage values, presented in Table 7, indicate that configuration 2, 4, and 5 are most empirically relevant (each 17%), while configuration 1 and 2 have the highest unique coverage values (11% each). In addition, the results of the parsimonious solution are reported in Appendix 2.

For example, configuration 2 indicates that even without strong implementation partners, the presence of stakeholder incentives, feasibility checks, synergies in the district

structure, transparent and comprehensible innovation development, short implementation time horizons, and a structured implementation management process are sufficient to ensure urban innovation implementation. This implementation was also achieved regardless of the presence of an established contact point. Configuration 4 indicates that regardless of a short implementation horizon, stakeholder incentives, an established contact point, feasibility checks, implementation partners, used synergies in the district structure, transparency and comprehensibility, and an implementation management are sufficient to ensure urban innovation implementation. This condition shows that the combination of all innovation drivers results in innovation implementation. Configuration 5 shows that regardless of stakeholder incentives, the existence of an established contact point, feasibility checks, strong implementation partners, synergies in the district structure, transparent and comprehensible innovation development, short implementation time horizons, and a structured implementation management process are sufficient for urban innovation development.

**Table 7. Results of the intermediate solution of implementation success**

<i>Condition</i>	<b>Implementation success</b>								
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>
Stakeholder incentives	○	●	●	●		●	●	●	●
Established contact point in the district	●		●	●	●	○	○	●	○
Feasibility checks	●	●	●	●	●	●	○	●	●
Implementation partner	○	○	○	●	●	○	●	○	●
Synergies in district structure	○	●	●	●	●	○	○	○	●
Transparency and comprehensibility	●	●	●	●	●	○	●	●	●
Short implementation time horizon	●	●	●		●	○	○	○	●
Implementation management		●		●	●	●	○	○	○
Consistency	.67	<b>.67</b>	.67	<b>1.00</b>	<b>1.00</b>	1.00	1.00	.67	.67
Raw coverage	.11	<b>.17</b>	.11	<b>.17</b>	<b>.17</b>	.09	.09	.06	.06
Unique coverage	.11	<b>.11</b>	.06	<b>.09</b>	<b>.09</b>	.09	.09	.06	.06
Solution coverage	.89								
Solution consistency	.79								

Intermediate solution; black circles represent the presence of a condition while white circles indicate negotiation, blank spaces indicate 'don't care' (Ragin and Fiss, 2008)  
 Frequency cutoff: 1.00  
 Consistency cutoff: .67  
 n=33 urban innovation projects

## Discussion

The study results indicate that urban transformation occurs in a complex and adaptive stakeholder (eco-)system (e.g., Anderson, 1999; Anderson et al., 2012; Roundy et al., 2018). Sustainable urban transformation is thus a multi-level change process that takes time and that allows considered and structured management to take the needs of climate change into account. Furthermore, the study results confirm that urban innovations cannot be developed and implemented without involving and empowering the urban ecosystem's stakeholders, those from the urban district in particular. Since urban innovations enable the recombination of existing urban structures, building a new – or renewed – urban regional ecosystem, it appears that a bottom-up approach that facilitates the assessment of the stakeholder structure and the gathering of information, including innovative ideas from such structures, is the most promising (e.g., Palmberg, 2009).

The current study shows that assessing the stakeholder structure and identifying key stakeholders at the beginning of the innovation process facilitate ecosystem access and information generation during the entire innovation development and implementation process (e.g., Nielsen et al., 2019). In order to enhance informed decision-making on urban innovation implementation, it is especially important to generate information on stakeholders' needs during the early stages of urban innovation (e.g., Lindkvist et al., 2019). Informed stakeholders who comprehend the purpose of urban innovations will present less resistance, even if they are not involved into the entire development process. Additionally, the implementation of solutions based on stakeholders' ideas, which are therefore district-specific and provide energy-efficient and cost-saving solutions, achieves higher acceptance rates and, consequently, faces lower innovation resistance.

Therefore, it is quite understandable that detailed feasibility checks, and transparency and comprehensibility are necessary for urban innovation implementation (see Table 6) to ensure that stakeholders support the goals of urban innovations and thus reduce the uncertainty caused by unpredictable stakeholder behavior during the innovation development phase (e.g., McCarthy et al., 2006). Detailed feasibility checks for different implementation scenarios further reduce the risk of implementation failures (e.g., Allen, 2001). The results of the QCA underline that a possible way to ensure stakeholder engagement is stakeholder incentivization (see Table 7), it being sufficient in seven of the nine possible solutions. Stakeholders who are highly dependent on existing urban infrastructures will expect large incentives to change their specific behavioral rules

(Redmond, 2003; Ponsiglione et al., 2018). Surprisingly, strong implementation partners, who may serve as key stakeholders, are not sufficient in five of the nine possible solutions, even though the literature states that multipliers, like key stakeholders, facilitate knowledge transfer and support implementation (e.g., Fligstein, 1997; Dacin et al., 2002; Lindkvist et al., 2019). In urban innovation, strong implementation partners are thus less important than, for example, feasibility checks, transparency, and stakeholder incentives. This is supported by one of the empirically most important configurations (configuration 2, Table 7), where the absence of implementation partners and the presence of the other innovation drivers are sufficient.

The fsQCA provides a toolbox with nine possible configurations to achieve urban innovation implementation. Not all previously identified drivers are relevant success factors. This confirms the complexity and adaptivity of urban innovations. Each urban ecosystem has a specific structure and the design of innovation development and implementation must be based on this specific structure. For example, if there is no possibility in a project to establish a local stakeholder contact point like an office, configurations 6, 7, and 9 nonetheless indicate possible ways to ensure urban innovation implementation. For example, regardless of the absence all other innovation drivers, the presence of stakeholder incentives, strong implementation partners, and transparent and comprehensive communication can still result in implementation (configuration 7). This configuration emphasizes the importance of stakeholder interaction and intensive collaboration (e.g., Caragliu and Del Bo, 2019).

However, it is not easy to ensure stakeholder involvement. Heterogeneous stakeholders, like incumbent firms, startups, residents, and public organizations, have different institutional backgrounds and different degrees of institutionalization. Consequently, their individual goals may not be in line with the urban government's social and political agenda (e.g., Landry, 2012). This inevitably leads to innovation resistance. Therefore, a challenge during urban innovation is to overcome institutional resistance by means of regulative and normative pressure (DiMaggio and Powell, 1983). The study results correspond with current research which indicates that inducements in the form of, for example, financial incentives for implementing sustainable technologies and the urban ecosystem's legitimization, encourage urban innovation (e.g., Berrone et al., 2013).

## **Implications and limitations**

### **Theoretical implications**

In an exploratory approach, this study stimulated a new research field in innovation management literature and proposed future avenues for a new theory of urban innovation. The study also provided an in-depth overview of the research status of urban innovation. Building on this, this paper provides valuable insights on the underlying processes in (sustainable) urban transformation (e.g., Geels et al., 2017) from a CAS perspective. Thereby, this study contributes to the call for research on the underlying mechanisms in the necessary transformation of complex systems to counter climate change (e.g., Levy and Liechtenstein, 2012).

This study also adds to stakeholder management literature by emphasizing the importance of stakeholders in urban ecosystems, due to urban innovation implementation's dependence on heterogeneous stakeholder groups and their interaction. Consequently, managing urban innovation implementation always means taking different stakeholders' needs into account. Furthermore, the study results promote a discussion on dealing with innovation resistance in complex innovation processes, like urban innovation, by providing theoretically driven and empirically validated strategies to overcome the implementation resistance. Thereby, this study extended the application of fsQCA. Furthermore, the paper merges insights from innovation management literature with CAS theory and transfers it to a different context.

### **Managerial implications**

The study has implications for urban innovation development and implementation that mainly addresses profit-oriented firms, but also policy makers and public institutions (e.g., Matei and Antonie, 2015). Additionally, this study delivers a toolbox for urban innovation managers that provides configurations of different innovation drivers which support implementation success while dependent on the urban ecosystem's structure. The results suggest that organizations should not simply transfer processes and knowledge from classical innovation management without taking the complexity of urban innovations into account. The stakeholders at the core of the urban ecosystem, which is urban transformation's objective, should be involved right from the start to overcome implementation barriers that may arise from the complex stakeholder structure. Identifying

the relevant individuals in the key stakeholder groups from real estate and housing companies, private owners, and implementation partners, like energy utilities, facilitates the subsequent implementation.

The data propose a three-step urban innovation process: First, managers should assess the urban area's structure, including the key stakeholders' and existing stakeholders' networks, as well as their individual goals to attain stakeholder empowerment. Second, managers need to develop events that merge the stakeholders' individual goals and assess stakeholder networks, including actors from private and public, by, for example, establishing events like regular meetings, discussion rounds, and workshops. This is necessary to motivate the stakeholders to collaborate and engage in detail planning for urban transformation, and may require innovative communication and integration channels, such as combining energy efficiency increase topics with circus entertainment. Further, this ensures transparency in the development process. Providing material and non-material incentives, like financial grants and supporting applications for public funding, further motivates stakeholders in this endeavor. Third, managers should guide the implementation of urban innovation alternatives by 'unfreezing' stakeholders through clear structures and formal management.

### **Research quality and limitations**

The research quality was ensured by closely adhering to the criteria for qualitative research proposed by Goffin et al. (2019). The research design is based on a theoretical foundation (complex and adaptive systems perspective to investigate different urban innovation projects). The data collection was chosen with care (in-depth interviews at two points in time, telephone interviews, and online search). Further, a rigorous data analysis was undertaken (case description, interpretation, and summary in a general valid process), also considering that its limitations reflect the research quality.

Despite its contributions, this study has several limitations. This paper is based on qualitative data from an urban innovation initiative in Germany, similar to other European urban transformation initiatives like *ÉcoQuartier* in France (Joss, 2015), even though the application area may be too narrow. Although the results are based on seven, respectively 33, different urban innovation projects representing urban and rural areas, they need further quantitative and international validation. This is especially true of the urban innovation

process that may differ in respect of different kinds of urban innovation projects, and the quantitative effects of stakeholder involvement on urban innovation success, including its implementation success and innovativeness. Although QCA is suitable for small sample sizes between  $n=10$  and  $n=50$  (Fiss, 2007; Rihoux and Ragin, 2009), the sample size could be extended to show that the results are generally applicable.

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## Appendix 1. Overview of urban innovation literature

Research stream	Publication	Definition urban innovation; Research question	Operationalization of urban innovation	Main findings
<b>Innovation in urban areas</b>	Simmie, 2003	Knowledge is a key resource for innovation and innovative firms develop this in regions. How important is local/urban knowledge for innovation?	Region as a context variable	Innovative firms concentrate on key metropolitan areas where they have a strong local knowledge base and connectivity to similar regions in the international economy.
<b>Innovation in urban areas</b>	Athey et al., 2008	A city's structure influences the development of innovations. How do strong/weak urban hubs and firms' strong/weak local links influence innovation development?	Conceptual framework that uses the number of product, service, and process innovations in cities	Cities with strong urban hubs have good transport and communication infrastructures to encourage collaboration between organizations and innovation. In cities with strong local links, a few firms have dense networks and deep anchors in urban institutions. Such local links are important for knowledge-intensive innovations.
<b>Innovation in urban areas</b>	Caragliu et al., 2016	Cities offer a competitive and challenging environment in which, regarding innovation, actors' individual characteristics will provide the highest returns. Do cities with a more open and positive attitude towards risk attract more individuals and thus generate more innovations?	As a dependent variable and innovations in cities as the number of patent applications to the European Patent Office	Cities with a more open and positive attitude towards risk tend to be more innovative. Traditional knowledge production factors do not influence the number of innovations. With regard to explaining urban innovation, urban attitude has a positive influence on risky endeavors.
<b>Innovation in urban areas</b>	Ning et al., 2016	The urban provides space for innovations, due to high knowledge spillovers through direct, unintended, and repeated interpersonal contacts. Which factors influence urban innovation?	As a dependent variable and innovation intensity as the domestic patent applications per 10,000 inhabitants	Foreign investments and diverse industry structure foster urban innovation; specialization decreases urban innovation.
<b>Innovation in urban areas</b>	Park and Park, 2016	Urban innovation is understood as urban growth resulting from technical innovation in urban areas with a strong urban agglomeration. How can technological innovations' local impact be measured?	Economic impact analysis: the change in warehouse and transportation activities regarding foreign imports and exports as a measure of urban growth	Using the example of the Panama Canal expansion, involving the U.S., the results show that the net impacts resulting from port modernization investments and shipping route changes will be an economic engine that will affect the U.S. However, trade diversion may reduce urban growth and innovation, while extended transportation and warehousing routes have the opposite effect.
<b>Innovation in urban areas</b>	Caragliu and Del Bo, 2019	Urban innovation is understood as the number of patents in a defined urban region. How does smart city policy intensity affect urban innovations?	As a dependent variable and as the total patent applications to the European Patent Office	Engagement in smart city policies above the EU average leads to higher patent application rates, whose effect is true in terms for high-tech patents in more narrowly defined classes.
<b>Innovation in urban areas</b>	Hamidi et al., 2019	Compact regions reduce barriers to innovation generation by offering high quality places and access to urban amenities. Is this relationship empirically valid?	As the average number of patents, firm innovations, and number of innovative small firms	The Metropolitan Compactness Index (comprising the relationships between regional compactness and the Regional Innovation Capacity) is positively associated with urban innovativeness.
<b>Innovative urban restructuring</b>	Hall, 2003	Four kinds of urban innovation: cultural/intellectual, technological, cultural-technological, and technological-organizational innovations. What comprises creativity in cities and how does it influence urban innovation?	Urban as the context variable required to build attractive cities	Active creativity means that the urban government produces flagship buildings and a high-quality urban ambience; passive creativity means showing people's creativity; cities compete to make themselves attractive for living and visiting.



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Research stream	Publication	Definition urban innovation; Research question	Operationalization of urban innovation	Main findings
<b>Innovative urban restructuring</b>	Wolfe and Bramwell, 2008	Innovation and creativity emphasize the continuing relevance of regions in general and urban regions as critical sites for determining economic performance. How does urban restructuring and governance influence a city's economic performance?	Economic performance as a consequence of urban innovations	Strategic planning to promote urban change; the creation and diffusion of new knowledge drive innovation in knowledge-intensive production and service activities, which, in turn, drive economic performance and growth. The underlying social dynamics of urban regions are particularly significant in shaping economic outcomes.
<b>Innovative urban restructuring</b>	Lehtovuori and Havik, 2009	Urban space enables creativity and innovation; consequently, urban planning must provide innovation-friendly cultural and social environments. Which urban planning approaches promote creativity and innovation?	Urban as a context variable that encourages creativity and innovation	Alternative site-specific approaches to urban planning policies, such as temporary use, breeding places policy, and urban curation, provide a cultural and social corrective to existing instrumental and more mainstream approaches. This may support the planning of creative spaces and the emergence of new, place-based approaches, which are linked to contemporary society's shifting locational logic of urban planning.
<b>Innovative urban restructuring</b>	Dente and Coletti, 2011	Urban innovations are all innovations in a city, including those in management and relationships with citizens. How can a city's innovativeness be measured?	Urban innovativeness: Agenda innovation, process innovation, product innovation, innovative communication	Cities must score high in all their innovation dimensions to be designated as innovative.
<b>Innovative urban restructuring</b>	Nam and Pardo, 2011	A smart city is an example of urban innovation that, depending on a city's unique structure, allows technological, managerial, organizational, and policy innovation. Which of a smart city's characteristics influence the management of change?	A smart city as the result of innovation in management, policy, and technology	A smart city is not only a technological concept, but also a socioeconomic and multi-sectoral one; it is not system-driven, but service-oriented. It is a national or global movement that does not revolute but evolves over time.
<b>Innovative urban restructuring</b>	Mieg, 2012	Urban innovation is any redefinition of urban space, like the complete reorganization of municipal budgets, the reconfiguration of stakeholder alliances, the revitalization of industrial sites, and the renovation or restructuring of urban districts. How does sustainable and urban development differ?	Science and technology parks as urban innovation project	Sustainable development is based on preservation; innovative development is based on a radical recombination of resources; sustainable and innovative urban development integration is required.
<b>Innovative urban restructuring</b>	Mulder, 2012	Development of innovative services that enrich everyday life. How can these services be developed?	Living lab concept; innovation development in user communities	Living labs enhance urban innovation (user-driven and co-creative).
<b>Innovative urban restructuring</b>	Khoms, 2016	A smart city as an urban innovation going beyond the traditional definition of product process innovations. How can urban innovations be implemented?	Urban innovation dimension: intelligent governance and intelligent districts	Establish structures to continuously involve stakeholders in the ecosystem to cooperate and collaborate with the city administration and with one another.
<b>Innovative urban restructuring</b>	Nilssen, 2019	Smart city initiatives focus on different innovation types to restructure the urban. Which smart city initiatives' typologies are based on the urban innovations that they target?	Urban development projects aimed at building smart cities	Four dimensions of (smart) urban innovation: technological, organizational, collaborative, and experimental.

## Appendix 1. Overview of urban innovation literature

Research stream	Publication	Definition urban innovation; Research question	Operationalization of urban innovation	Main findings
<b>Urban innovation ecosystem</b>	Zygiaris, 2013	Urban space to build green, smart, open, intelligent innovation ecosystem; i.e. the urban innovation ecosystem. How can this urban innovation ecosystem be built?	Urban innovation ecosystem as a context	City's urban resources, infrastructures, utilities, services, and stakeholders' reasons for building urban innovation ecosystems; innovative if new business models are developed and capitalized; smart policies are needed.
<b>Urban innovation ecosystem</b>	Li et al., 2015	Topological and spatial features, like scientific and technological knowledge, characterize urban innovation networks. What comprises a city's innovation network and how can it use this?	Urban innovation network as a context	Scientific knowledge networks have a multi-dimensional proximity (social, organizational, cognitive, and geographical) that leads to knowledge spill-over and innovation. This spill-over and innovation do not apply to technological knowledge networks. The network type helps determine urban innovation policy.
<b>Urban innovation ecosystem</b>	Sarma and Sunny, 2017	A smart city as an urban innovation comprising the implementation of information and communication technologies with the citizens' active participation in order to achieve a regional competitive advantage. Which roles do stakeholders and entrepreneurs play in smart cities?	Urban innovation/smart city as a context	Smart cities encourage economic growth, social development, collaborative dialogue, and innovative technologies through diverse ecosystem actors and local entrepreneurs' involvement.

**Appendix 2. Results of the parsimonious solution of the implementation success**

<i>Condition</i>	<b>Implementation success</b>											
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>	<i>11</i>	<i>12</i>
Stakeholder incentives		●	●	○	○	○			○			
Established contact point in the district		○						●	●	●	●	●
Feasibility checks				●						●		
Implementation partner							○		○	●	●	●
Synergies in district structure	○		●	○	○	○	○	○	○			●
Transparency and comprehensibility	●				●						●	
Short implementation time horizon		○	●			●	●	●				
Implementation management	○									●	●	●
Consistency	.78	1.00	<b>.72</b>	.67	.67	.67	.67	.67	.67	1.00	1.00	1.00
Raw coverage	.20	.17	<b>.37</b>	.11	.11	.11	.11	.11	.11	.26	.26	.26
Unique coverage	.05	.09	<b>.29</b>	.00	.00	.00	.00	.00	.00	.00	.00	.00
Solution coverage	.89											
Solution consistency	.79											

Parsimonious solution; black circles represent the presence of a condition while white circles indicate negotiation, blank spaces indicate 'don't care' (Ragin and Fiss, 2008)  
Frequency cutoff: 1.00  
Consistency cutoff: .67  
n=33

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### **Paper 3: The more the better? The role of stakeholder involvement and digital tools in urban innovation projects**

Julia Kroh; Carsten Schultz

#### **Abstract**

Urban renewal is increasing in relevance, mainly due to the need to address climate change. In pursuit of this goal, urban innovations target the development and implementation of collectively used infrastructures and resources in cities, like smart city solutions. These endeavors require the involvement of stakeholders to identify their needs and to garner their active support in urban environments. As a result, urban innovation projects can implement concrete solutions for ecological sustainability in local ecosystems that display multiple and frequent conflicting interests. Our study draws on stakeholder theory to investigate how the breadth of stakeholder involvement (the number of different stakeholder groups) and the depth of stakeholder involvement (the collaboration intensity with external stakeholders during the early innovation phase) affect the implementation orientation of urban innovation projects. Building on the perspective of information processing theory, we suggest that the efficacy of stakeholder involvement depends on the use of digital involvement and formalization tools. To explore these relationships, we analyze 106 urban innovation projects for energy efficiency improvements in German city districts. We use a text mining analysis of planning documents to assess the implementation orientation of targeted innovations and survey data to measure the independent variables. The results provide empirical evidence that (i) a broad stakeholder involvement affects urban innovations' implementation negatively, but a deep involvement of stakeholders has the opposite effect. Further, (ii) intensive use of digital involvement tools supports deep stakeholder involvement positively, but hampers broad stakeholder involvement. Finally, (iii) a high degree of IT supported project formalization weakens the positive effect of stakeholder involvement intensity on the implementation orientation.

Keywords: Stakeholder management; information processing theory; urban innovation; sustainable urban transformation; innovation implementation

## Introduction

Urban renewal is increasing in relevance due to ongoing urbanization and the need to manage climate change (e.g., Joss, 2015). In a world where more than half the population lives in urban areas (United Nations, 2018), the reduction of energy and resource consumption in cities plays a central role in fulfilling sustainability goals (Rousseau et al., 2019). Thus, there is a dire need for urban innovation projects that develop new and sustainable ideas (e.g., Mieg, 2012). However, the development of urban innovation alternatives only effects energy efficiency when these alternatives are implemented in urban areas. Irrespective, the implementation depends on a complex and adaptive ecosystem of heterogeneous stakeholders (Cozijnsen et al., 2000; Farías and Bender, 2010; Bogers et al., 2016; Aarikka-Stenroos et al., 2017; Nielsen et al., 2019).

For example, an urban innovation project in Germany developed and implemented innovative district heating that combines solar energy for heat supply, using a 560 m<sup>3</sup> water-filled energy storage. In winter, the energy is extracted from the storage for district heating so that, by the end of the season, the storage is filled with ice. During the following summer, solar energy is used to thaw the ice and heat the water for the next winter. It took the project team four and a half years to develop and implement the system, mainly because changing stakeholders increased management requirements. An energy planning office acted as the project leader and collaborated with the city council, the climate management, and public and private homeowners to ensure the system's acceptance. A multinational firm served as the technology supplier and cooperated closely with the local energy supplier, who operates the system, and the federal environment department that supported the system implementation through public funding. Both the technology supplier and the energy supplier joined the process during the later innovation development stages, along with their own project goals. Therefore, the project team had to involve the stakeholders and balance the conflicting goals to attain implementation. The goal of district heating was realized, only because the project team was able to manage the heterogeneous stakeholders and their interests.

This example illustrates that urban innovation development requires the flexible and well-organized involvement of heterogeneous stakeholders to resolve information asymmetries and to align innovation activities with stakeholders' needs (e.g., Caragliu et al., 2016; Planko et al., 2017). Gathering and processing stakeholder information thus become a main success factor in urban innovation (Byrd, 2007; Flammer and Kacperczyk,

2016). However, because of anticipated coordination problems, the integration of all relevant stakeholder groups can exceed the project teams' information processing capabilities, increase the project complexity, and hamper urban innovation (Galbraith, 1974; Patanakul et al., 2012; Lindkvist et al., 2019). These challenges can decrease the ability of urban innovation projects to implement the intended innovative solutions. To the best of our knowledge, current research does not clarify the conflict between the required involvement of stakeholders to develop effective innovation, and the limited implementation efficiency brought about by high levels of complexity and coordination costs while collaborating with a heterogeneous group of stakeholders. Therefore, we analyze how stakeholder involvement breadth (i.e., the number of relevant stakeholder groups) and stakeholder involvement depth (i.e., the collaboration intensity with external stakeholders during the early innovation phase), influence the implementation orientation of innovation projects, and how internal and external information processing tools facilitate stakeholder involvement.

Although the importance of complex innovations like urban innovation increases over time (e.g., Hillebrand et al., 2015; Reypens et al., 2015; Watson et al., 2018), the effects of stakeholder involvement in these situations remain unclear. Involving stakeholders increases the entire knowledge base and, therefore, positively affects a firm's performance, its competitive advantage, and its innovation performance (e.g., Harrison et al., 2010; Li et al., 2018; Meireles et al., 2018). Even more so, recent research shows that intensive stakeholder involvement is important in complex innovation processes, like urban innovation (e.g., Di Maddaloni, and Davis 2017; Mok et al., 2017; Yu et al., 2017; Juntunen et al., 2019), where different innovation dimensions, such as technological, organizational, and collaborative innovations, are relevant (e.g., Nilssen, 2019). But recent literature also states that the number of relevant stakeholder groups restrict the positive effect of stakeholder involvement on innovation implementation (e.g., Harrison and Bosse, 2013; Garcia-Castro and Francoeur, 2016). Increasing the breadth of stakeholder involvement increases the need for the formalization of information and decision processes, both resulting in losses of efficacy and efficiency. In urban innovation projects, this could result in lower implementation rates because the project team might focus on stakeholder coordination instead of innovation implementation. This is especially true for innovation processes that require the involvement of stakeholders with conflicting goals (e.g., Hertel et al., 2019), as the project team must resolve conflicts before it can initiate the

implementation (Torugsa and Arundel, 2016). Thus, our first research question is: *How do stakeholder breadth and stakeholder involvement depth influence urban innovation's implementation orientation?*

Managing urban innovation projects calls for information processing capabilities to gather stakeholder information and to organize and process it in the project team, because, drawing on information processing theory, an information processing capability reduces uncertainty and promises higher innovation performance (Galbraith, 1974; Tatikonda and Montoya-Weiss, 2001; Silva et al., 2019). Digital tools increase both external and internal information processing capabilities. Digital involvement instruments, like social media, online idea sourcing, and web-based toolkits, increase the external information processing capability and thus facilitate stakeholder involvement (e.g., Von Hippel, 1994; Veldhuizen et al., 2006; Gordon et al., 2008; Marion et al., 2014). Internal information processing capabilities increase with information technology (IT) supported formal structures that coordinate the activities of the project team, such as process management software and decision support systems (e.g., Gann and Salter, 2000; Schultz et al., 2019). However, the intensive use of digital tools for project management may lead to a high degree of formal planning and control approaches by the project team which in turn could decrease the project team's stakeholder orientation (Aggeri and Segrestin, 2007; Kavanagh and Naughton, 2009). Furthermore, formal management methods facilitate internal coordination, but hamper the project team's flexibility and, subsequently, also the absorption of stakeholder's contributions. The reason is that it is not possible to deal with heterogeneous and inconsistent information when processes are too strictly defined. Therefore, project teams may have a decreased absorptive capacity. Although this could be true for the adaptive urban ecosystems of urban innovation (e.g., Ranta et al., 2019), a project team nevertheless needs different tools for stakeholder involvement and innovation project management (Durmuşoğlu and Barczak, 2011; Marion et al. 2016). This often leads to a confusing number of digital tools that could increase the complexity of the urban innovation project and decrease the information processing capability, especially when the digital tools do not fit the different project team's organizations' IT systems and when the coordination effort is too demanding (Khallaf et al., 2017; Kroh et al., 2018). Thus, our second research question focuses on the relevant information processing mechanisms in urban innovation: *Which information processing mechanisms influence the efficiency and efficacy of stakeholder involvement in urban innovation?*

Drawing on instrumental stakeholder and information processing theory, this study introduces stakeholder information processing capability as a mean to achieve a high level of innovation implementation in urban innovation projects. The results are based on text mining and survey data from 106 urban innovation projects that are part of a German urban innovation initiative for energy efficiency improvements in urban districts. We use the text mining analysis of planning documents to assess the implementation orientation of targeted innovations and the survey data to measure the independent variables. We thus respond and contribute to the call for research on stakeholder involvement mechanisms in complex innovation projects (Da Silva et al., 2019). Furthermore, we establish text mining as a research method in innovation management by introducing a more fine-grained measure for innovation implementation. To the best of our knowledge, innovation management literature does not consider implementation orientation as a performance measure in ecosystems (e.g., Aarikka-Stenroos and Ritala, 2017), mainly because most of the empirical studies focus on an organization's innovation activities in an ecosystem (e.g., Adner and Kapoor, 2010).

## **Theoretical framework and hypotheses development**

### **Stakeholder information processing capability in complex innovation**

The tacit knowledge of the heterogeneous stakeholders in the ecosystem increases the complexity of innovation projects like urban innovation (Bogers et al., 2016; Visnjic et al., 2016). Complex innovation requires a large amount of ecosystem knowledge in order to assess the heterogeneous stakeholders' needs, activities, and behaviors (De Luca and Atuahene-Gima, 2007; Van Bockhaven and Matthyssens, 2017; Fliaster and Kolloch, 2017; Nielsen et al., 2019). This assumption is in line with instrumental stakeholder theory (Donaldson and Preston, 1995; Jones, 1995; McQuater et al., 1998) which suggests that stakeholder management strategies can produce the desirable outcomes of innovation projects (e.g., Schuster and Holtbrügge, 2014; Miller et al., 2017; Jones et al., 2018), such as a high level of financial and innovation performance (e.g., Harrison et al., 2010; Robeson and O'Connor, 2013). In the case of urban innovation projects, especially where industry, government, and research institutes collaborate to develop and implement supportive system innovations to cope with climate change, conventional performance measures may not be appropriate (e.g., Planko et al., 2017). Against the backdrop of the stakeholder ecosystem's complexity and the associated long time horizon of implementation,



innovation implementation becomes a desirable outcome and performance measure (e.g., Lindkvist et al., 2019). Additionally, and as an example, it is difficult to measure the financial performance of these system innovations. Therefore, in this context, implemented innovation alternatives that result in sustainable urban transformation are more appropriate.

The advantages of stakeholder involvement are only generated if based on the assumption that stakeholders' information is gathered and processed within an organization or a project team and that knowledge transfer is guaranteed (e.g., Dente et al., 2005). In this regard, organizational information processing theory states that an information processing capability facilitates the fulfilment of an organization's information needs and its ability to cope with uncertainties in its environment (Galbraith, 1974; Tushman and Nadler, 1978). Nevertheless, any mismatch between the information requirements of an innovation (e.g., resulting from its degree of complexity and uncertainty) and the information capability of the organization, will lead to reduced innovation performance (e.g., Kroh et al., 2018). For example, an increase in the number of relevant stakeholders and their interdependence results in increasing uncertainty and a higher demand for coordination (Sommer and Loch, 2004; Pauget and Wald, 2013). Drawing on instrumental stakeholder theory, stakeholder information processing capability is therefore an instrument to achieve a high level of innovation performance (e.g., Tatikonda and Montoya-Weiss, 2001).

Organizations have two alternatives to resolve information processing mismatches (Galbraith, 1974). First, they can decrease the information processing requirements, but these are difficult to influence since they are, in case of urban innovation, determined by the characteristics of the project (Ahmad et al., 2013). Second, they can increase their own information processing capabilities by, for example, building communication infrastructure, accomplishing goal congruence, and establishing clear leadership and project structures (e.g., Moenaert et al, 2000; Schultz et al., 2019). Nevertheless, urban innovation projects as temporary organizations (Lundin and Soederholm, 1995; Schreyoegg and Sydow, 2010; Sydow and Braun, 2018) lack organizational routines (Geraldi et al., 2011; Hadida et al., 2019). Organizational routines support the use of heterogeneous knowledge and increase social capital (Wong et al., 2011). Frequent collaboration within an organization that increases its information processing capability also promotes the success of inter-organizational innovation projects (Schleimer and Faems, 2016). However, research suggests that these strong routines decrease the flexibility

of knowledge integration and transfer, which specifically benefits complex and radically new innovation projects (Patanakul et al., 2012).

Information processing theory, in particular, emphasizes structural mechanisms that generate, process, and distribute information to fulfil innovation tasks (Tushman and Nadler, 1978; Daft and Lengel, 1986). Organizations manage their information processing needs by using different communication practices, depending on the innovation development stage and the salience of the stakeholder group (e.g., Turkulainen et al., 2015). Impersonal communication modes rely on project formalization mechanisms, including the use of project plans, the establishment of project management tools and software, and the allocation of responsibilities, and thus have minimum verbal communication requirements and high standardization potential (Galbraith, 1974; Van de Ven et al., 1976). Personal and social modes rely on personal communication and flexible interaction with external stakeholders and are supported by digital interaction tools like social media (e.g., Waters et al., 2009; Poetz and Schreier, 2012).

Innovation literature highlights the role of IT as a structural mechanism to increase information processing capability by extending the existing information systems' technical level to easily process large amounts of information (Bensaou and Venkatraman, 1996; Ben-Arieh and Pollatscheck, 2002; Fairbank et al., 2006; Kroh et al., 2018). Digital tools that extend the information processing capability have a direct and positive impact on the innovation performance (Dias et al., 2014; Peng et al., 2014; Mauerhoefer et al., 2017). Digital tools are important in urban innovation because they support knowledge transfer and decrease project complexity and coordination costs (e.g., Bhatt et al., 2010; Im et al., 2013; Lindkvist et al. 2019). Thereby, it is necessary to use different digital tools that support information gathering and information optimization, in order to increase development speed and innovation quality in inter-organizational projects (González-Zapatero et al., 2019; Sivarajah et al., 2019).

However, large initial investments in IT may not necessarily result in higher project performance and costs could even exceed the benefits (David, 1990; Oz, 2005; Khallaf et al., 2017). The adoption and diffusion of digital tools require competitive capabilities like IT expertise and dynamic capabilities such as organizational learning from organizations (e.g., Bhatt and Grover, 2005; Mauerhoefer et al., 2017). Further, there is a perceived lack of procedures to govern the use of digital tools like social media (Kanagarajoo et al., 2019).

Temporary organizations may not be able to overcome this IT productivity paradox, because of the restrictions imposed by their temporary existence (e.g., Hadida et al., 2019). Digital tools that support formalization also support the achievement of project goals. However, a too strong focus on these digital tools and subsequently also on internal efficiency may lead to a reduced external focus and creativity losses (e.g., Lee and Choi, 2003). As a result, urban innovation project teams could lose stakeholder focus.

### **Influence of stakeholder breadth and depth on complex innovation implementation**

In general, intensive knowledge exchange with external stakeholders may result in higher innovation performance (e.g., Kassinis and Vafeas, 2006; Laursen and Salter, 2006; Cousins et al., 2011). While a plethora of literature discusses the positive influence of stakeholder involvement, only a few studies investigate the context and complimentary assets on which the efficacy of stakeholder management depends. Table 1 summarizes previous empirical research. For example, the existing research indicates that organizations can overinvest in stakeholder involvement tools (Garcia-Castro and Francoeur, 2016), and that intensive collaboration with different stakeholder groups could result in downsides, due to its negative interaction effects (Li et al., 2018).

In large stakeholder ecosystems, like urban infrastructural renewal projects, multiple interests need to be governed and organized (e.g., Kazadi et al., 2016; Di Maddaloni, and Davis 2017; Yu et al., 2017). It is necessary that for-profit stakeholders, like real estate companies, collaborate with non-profit stakeholders, such as policy makers and public institutions, and with stakeholders with private backgrounds, like residents (Torugsa and Arundel, 2016). All these actors influence one another, also considering that the public community could, for instance, foster organizations' environmental activities (Kassinis and Vafeas, 2006).

**Table 1. Overview of research on stakeholders' influence dependencies**

Effect of stakeholder influence depends on....	Paper	Research focus	Outcome	Role of stakeholders and implications
<b>.. stakeholders' closeness to the firm</b>	Hillman and Keim, 2001	Relationship between shareholder value, stakeholder management, and social issue participation (participation in activities that are not directly related to primary stakeholder management) based on data from S&P 500 firms	Shareholder value	Only primary stakeholder management (employees, customers, suppliers, and communities) results in increased shareholder value, while social issue participation, like avoiding nuclear energy, is negatively associated with shareholder value; Stakeholder management needs to focus on a firm's relevant activities
<b>... stakeholders' knowledge transfer capabilities</b>	Surroca et al., 2010	Relationship between social and financial performance independent on intangible resources based on stakeholder management with quantitative data from 599 firms	Financial performance	Corporate social performance influences financial performance only through the increase in intangible resources; intangible resources like knowledge, reputation, human capital, and knowledge are built up through stakeholder collaboration
<b>... stakeholder motivation</b>	Bridoux and Stoelhorst, 2014	Fairness approach based on the assumption that all stakeholders care about fairness positively influences firm performance	Firm value creation	Stakeholder management is not generalizable and depends on a firm's specific situation, why the influence of a homogenous stakeholder management approach may result in the under and overestimation of performance; For example, a fairness approach is more effective in attracting, retaining, and motivating reciprocal stakeholders, while an arms-length approach is more effective in motivating self-regarding stakeholders to create value
<b>... stakeholder groups and firm/market's characteristics</b>	Garcia-Castro and Francoeur, 2016	Relationship between investing in instruments for stakeholder relationships and firm performance based on data from 1,060 multinational firms	Financial performance	Stakeholder investments are more effective when done simultaneously across all relevant stakeholder groups; Overinvestments in stakeholder instruments can result in firm underperformance; Positive and negative effect relies on industry, differentiation, innovation, and national-legal system features, e.g., firms with a low differentiation and low innovativeness can gain a competitive advantage by high stakeholder investments, for example by establishing close relationships
<b>... stakeholder groups</b>	Li et al., 2018	Influence of governmental and economic stakeholders on a firm's innovation performance based on data from 26,400 firms	Firm innovation performance	Each stakeholder group influences the innovation performance positively, but interaction between different stakeholder groups may lead to downsides; for example, firms that collaborate intensively with political and economic stakeholders do not profit in terms of innovativeness
<b>... stakeholder responsiveness</b>	Zhao and Murrell, 2016	Relationship between corporate social and corporate financial performance as a replication of Waddock and Graves (1997) with data from 1991-2013 firm ratings	Three performance measures (ROA, ROE, and ROS)	Mixed relationship between social and financial performance; Prior high financial performance results in higher social performance, but prior high social performance is not related to high financial performance; stakeholders may thus not necessarily respond better to stakeholder management activities
<b>... organizations' legitimacy</b>	Desai, 2018	Exploration of how organizations balance knowledge search and exploration from stakeholders and their organizational legitimacy based on 2,380 agency-year observations of public organizations	Collaboration intensity	Collaboration facilitates access to external information; organizations pursue it when they need to solve problems, but suppress collaboration when their legitimacy is potentially or already at risk and stakeholders may hold organizations accountable for information which is needed to solve related problems, but suppress their use of collaboration to solve problems when their legitimacy is potentially or already at risk, such as when powerful stakeholders can hold an organization accountable for inappropriate acts or when some organizational actions have already been deemed as controversial.

Previous research investigated stakeholder identification mechanisms to account for all potential stakeholders in different innovation projects (e.g., Oral et al., 2001; Winch, 2004; Aaltonen et al., 2008; Achterkamp and Vos, 2008). Stakeholder involvement depth also assists in overcoming information asymmetries. At the front end of innovation, involvement is necessary to account for all the needs of the stakeholders and it should continue in the later development stages when the involvement contributes to stable and trustful relationships (Preston and Donaldson, 1999; Jones et al., 2018; Meireles et al., 2018). Furthermore, the involvement of stakeholders could decrease innovation resistance and increase implementation rates (De Schepper et al., 2014; Olsen et al., 2016; Grimpe et al., 2019; Juntunen et al., 2019). In urban innovation, implementing a large number of innovation alternatives is indicative of a high level of urban transformation and thus a high project performance (e.g., Joss, 2015).

Nevertheless, despite these positive effects of stakeholder involvement on innovation performance, complex urban innovation projects are accompanied by a broad range and confusing number of affected groups and individuals with different attitudes toward the innovation project and with different levels of salience during innovation implementation (e.g., Carmin et al., 2003; Olander, 2007; Aaltonen et al., 2015; Goodman et al., 2017). Thus, the complexity of the innovation projects could exceed the information processing capability of the temporary organizations in urban innovation development (e.g., Turkulainen et al., 2015; Li et al., 2018). Furthermore, a wide stakeholder breadth leads to coordination challenges and an increase in the efforts of information and decision processes, both having possible disadvantages for efficiency and efficacy. Hence, stakeholder prioritization seems promising in order to reduce the number of relevant stakeholders to key stakeholders who would be able to deliver the necessary information to ensure the innovation projects' success (e.g., Mitchell et al., 1997; Banks and Vera, 2007; Eesley et al., 2016; Watson et al., 2018).

As such, we conclude that stakeholder involvement is a double-edged sword. Although urban innovation implementation affects many stakeholders, only a limited and well-chosen number of stakeholders should be involved on an intensive basis. This would ensure a strong implementation orientation, given the fact that deep stakeholder involvement closes the information gap between organizations who develop complex innovations and their stakeholders.

*Hypothesis 1a: Stakeholder involvement breadth, that is a large number of relevant stakeholder groups, has a negative influence on urban innovations' implementation orientation.*

*Hypothesis 1b: Stakeholder involvement depth, that is intensive involvement of key stakeholders, positively influences urban innovations' implementation orientation.*

### **The moderating role of IT to increase information processing**

Digital tools support internal and external coordination in innovation projects and have a positive effect on innovation performance (e.g., Tatikonda and Rosenthal, 2000; Kleinschmidt et al., 2010; Durmuşoğlu and Barczak, 2011). The aim of their use is to collect and analyze data obtained from ecosystem's stakeholders, to better understand their current and future needs and behavior (e.g., Day, 2011; Driessen et al., 2013; Mahr et al., 2014), and to determine an organization's willingness to collaborate (e.g., Crilly et al., 2016). The larger the number of available digital tools (e.g., online communities, crowdsourcing platforms, and social media), the greater the probability of getting in touch and communicating with the stakeholders, which subsequently leads to better informed decisions on the innovation alternatives supported by an organization (e.g., Poetz and Schreier, 2008; Zahay et al., 2011; Marion et al., 2016). Urban innovation projects, in particular, benefit from the use of digital tools like social media (e.g., Kanagarajoo et al., 2019), because this usage benefits the involvement of non-profit stakeholders (Xu and Saxton, 2019).

As described above, stakeholder breadth could reduce the intensity of urban innovations' implementation orientation, because the stakeholder breadth increases coordination efforts and exceeds the project team's limited implementation resources (e.g., Frow et al., 2016; Garcia-Castro and Francoeur, 2016). The comprehensive use of digital involvement tools further adds to the amount and variance of heterogeneous information the organization needs to process. On the one hand, digital tools enable the project team to engage stakeholders who cannot be engaged by means of analog tools. These stakeholders, however, could differ depending on their interests, also considering that these conflicting goals could hamper urban innovation implementation (e.g., Liu et al., 2018). On the other hand, because of simplified communication access, digital tools foster reservations and criticism. This eases the way for strong and unified stakeholder opposition (e.g., Cuppen

et al., 2016) that, furthermore, could increase a team's coordination efforts and hamper the implementation of urban innovation. Due to the increase in complexity, the temporary organization's information processing capabilities and its absorptive capacity are likely to be exceeded. In this case, an urban innovations' project team may rather focus on stakeholder and instrument coordination and thus lose the implementation focus.

*Hypothesis 2a: The comprehensive use of digital involvement tools strengthens the negative influence of stakeholder breadth on the implementation orientation.*

In urban innovation, stakeholder involvement depth leads to innovations that are closely aligned with the stakeholders' needs. The comprehensiveness of the involvement tools used allows the accumulation of as much information as possible from the optimum number of individuals per stakeholder group, thereby generating deep ecosystem knowledge (De Luca and Atuahene-Gima, 2007). Therefore, since the developed urban innovation alternatives are more customized, they could gain more stakeholder acceptance; an outcome that results in a higher level of innovation implementation. In the event of deep stakeholder involvement, a broad set of digital IT tools can positively impact on implementation orientation.

*Hypothesis 2b: The comprehensive use of digital tools strengthens the positive relationship between stakeholder involvement depth and the implementation orientation.*

The goal of internal IT is to support and formalize information processing structures within an organization and to improve general information flows between innovation project members (e.g., Song and Song, 2010, Marion et al., 2014). IT supported formal structures (e.g., decision support systems for project evaluation, file transfer protocols, process management software), in particular support complex organizational tasks by assigning clear responsibilities, tasks, and milestones (e.g., Gann and Salter, 2000; Davies and Hobday, 2005). Thus, formalization can enable urban innovation projects to attain their implementation goals (Munns and Bjeirmi, 1996; Lindkvist et al., 2019).

By increasing the breadth of stakeholder involvement, the need also increases for coordination and organization. Therefore, IT supported formal management that structures the urban innovation process, also eases broad stakeholder involvement (e.g., Dos Santos et al., 2008; Richtnér and Sodergren, 2008). Independent of the depth of involvement, a high degree of IT supported formalization thus facilitates accountability regarding the

needs of broad stakeholder involvement and, therefore, supports urban innovation implementation.

*Hypothesis 3a: A high level of IT supported formal management mitigates the negative influence of stakeholder breadth on implementation orientation.*

Paradoxically, concerning deep stakeholder involvement, a high degree of formalization could produce the opposite result (Aggeri and Segrestin, 2007; Kavanagh and Naughton, 2009). IT supported formal management methods provide a framework to coordinate stakeholders but hamper the absorption of stakeholder's contributions; the reason is that the handling of heterogeneous and possible inconsistent information is not possible when processes are too strictly defined. A high level of formalization thus decreases a project team's absorptive capacity, which correlates positively with the use of external information in innovation (e.g., Lane and Lubatkin, 1998). Besides predefined routes, deep stakeholder involvement is also characterized by personal and spontaneous interaction. This flexibility is reduced in strongly formalized settings where organizational processes focus on internal information demands. For deep stakeholder involvement, project members collaborate closely with stakeholders and thus have lower internal coordination needs (Dietrich et al., 2010). Especially in complex urban ecosystems that rely on personal relationships between stakeholders and project team members, IT supported formal structures can generate unnecessary bureaucratic effort that hampers implementation.

*Hypothesis 3b: A high level of IT supported formal management weakens the relationship between stakeholder involvement depth and implementation orientation.*

## **Methods**

### **Data sample**

The hypotheses were investigated based on text mining and survey data from a public-funded German urban innovation initiative, with the goal of increasing energy efficiency and decreasing carbon emissions through the transformation of existing urban space. A project team develops innovation alternatives for innovative urban restructuring in the districts of small, medium-sized, and large cities. The project team consists of two to ten different organizations representing, for example, public administration, energy providers,



and real estate companies. The project team proposes innovation alternatives for implementation in a specific urban environment. We define stakeholders as any group and individuals, for example representing private homeowners, industry, and public institutions, who are actively involved in and affected by urban innovation activities. Following the conclusion of the development phase, the project team summarizes their innovation alternatives in the form of a written planning document. We focus on the front end of urban innovation development, and 169 of these written documents form the database of our text mining analysis. The funding guidelines include, but are not limited to, an in-depth investigation of a city district's initial situation, the development of concrete alternatives, and the mobilization, information, and extensive consultation of stakeholders (Kreditanstalt für Wiederaufbau, 2019). Stakeholder analysis and involvement is thus an integral part of the urban innovation projects. Because the overall objective of the initiative is the same for all project teams, the list of potential innovation alternatives is a constant. Therefore, we can compare the nature of individual innovation projects within our sample.

To overcome the likelihood of common method bias, the organizations of all 169 project teams were invited to participate in a survey on stakeholder management, and on IT and project management tool use. In total, this research draws on 106 urban innovation projects from different regional ecosystems, including 135 organizations (1.27 participating organizations per urban innovation project; high response rate 63% of the invited urban innovation projects) and their responses. Table 2 indicates additional sample characteristics like the regional ecosystem's size (represented by the cities' size) and the organizations' functional background.

**Table 2. Sample characteristics**

<b>Size of the regional ecosystem (based on the city's size)</b>	<b>Number</b>	<b>Percent</b>	<b>Size of the urban innovation project (based on the city districts' inhabitants)</b>	<b>Number</b>	<b>Percent</b>
Rural community (<5,000 inhabitants)	10	9.43%	<1,000	35	33.02%
Small town (5,001-20,000 inhabitants)	30	28.30%	<2,500	27	25.47%
Medium-sized town (20,001-100,000 inhabitants)	39	36.79%	<5,000	20	18.87%
Large city (>101,001 inhabitants)	27	25.47%	≥5,000	24	22.64%

<b>Number of informants per urban innovation project</b>			<b>Size of the project team</b>	<b>Number</b>	<b>Percent</b>
1 informant	82	77.36%	2 team members	19	17.92%
2 informants	20	18.87%	3 team members	37	34.91%
3 informants	4	3.77%	4 team members	21	19.81%
			5 team members	11	10.38%
			6 team members	4	3.77%
			≥ 7 team members	13	12.26%
			not available	1	0.94%

n=106 urban innovation projects

<b>Type of participating organization</b>	<b>Number</b>	<b>Percent</b>
Architects/Engineers/Planners	65	48.15%
Community/City	16	11.85%
Construction company	1	0.74%
Energy agency	8	5.93%
Energy provider	12	8.89%
Housing company/Real estate company	4	2.96%
Research institute	11	8.15%
Others	18	13.33%

n=135 organizations

## Measures

We follow the principle of sentiment analysis in opinion mining (e.g., Meyer et al., 2008; Pang and Lee, 2008) to assess the dependent variable *implementation orientation*. As urban innovation projects have an implementation horizon longer than five years, and because each project team had a clear implementation focus during the innovation development phase, we assume that the more often words like ‘implementation’, ‘realization’, and ‘application’ are used in a planning document, the higher the measure of the implementation orientation. Evaluating the implementation orientation based on its wording corresponds with recent literature (e.g., Uotila et al., 2009), and is also reasonable as the project teams investigate the cities’ district structures in depth during the development phase. The planning document thus shows how intensively a project team considered the actual implementation and how they intend to encourage the

implementation of their developed innovation alternatives. After reading a random sample of a third of the included 169 planning documents, it was assumed that innovation alternatives without an implementation purpose were not recorded in the planning documents. This is the reason why an analysis of word bigrams like ‘not implemented’ was excluded from the measure of the implementation orientation.

To assess the dependent variable, the documents of the 169 urban innovation projects were decomposed into text blocks, containing only words that occurred more than once per planning document, resulting in a document-term-matrix with a sparsity of 94%. We excluded these words to increase the validity of our measure. Afterwards, we developed a wordlist containing 111 German words accounting for 15 word families that indicate a high willingness to implement the urban innovation alternatives (see Appendix 1), and assessed its content validity via two individual researchers who evaluated the wordlist independently from each other. Additionally, an expert who was a member of several urban innovation project teams evaluated the inclusiveness of the wordlist. The implementation orientation was then measured as follow: The number of words from the wordlist was counted in every decomposed planning document and divided by the total number of the planning document’s words. This weighted word count was then used to represent implementation orientation in the subsequent regression analysis.

The text mining data was combined with survey data, based on established indicators drawn from prior research and measured with five-point Likert-type scales. The variables, which were assessed by several project team organizations for each urban innovation project, were aggregated to an urban-innovation-project score by calculating the mean values across their individual responses. The applied measures from previous measures were tested for validity and reliability, and Cronbach’s alpha coefficient was calculated, which ranged at satisfactory levels above the threshold of .7 (Nunnally and Bernstein, 1978). Principal component analysis (promax rotation), which was conducted separately for the items of each construct, only extracted one factor with eigenvalues greater than one, demonstrating these items’ unidimensionality (see Appendix 2). Further, the variance inflation factors that test for potential multicollinearity were below the recommended threshold of 10 (Hair et al., 2009) for all predictors (highest variance inflation factor 2.79 representing depth of stakeholder involvement in the linear regression). The means, standard deviations, and correlations for the variables are reported in Table 3.

**Table 3. Mean, standard deviations, and correlation matrix**

Construct	Mean	S.D.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1. Content breadth	18.15	10	(-)											
2. District size	3,162	3,683	.119	(-)										
3. Stakeholder involvement experience	1.03	.74	.088	.023	(-)									
4. Project experience	3.65	7.04	.015	-.044	-.012	(-)								
5. Organizational degree of innovativeness	2.84	.81	.232*	-.165	.149	.047	(-)							
6. Technological degree of innovativeness	2.93	.90	-.055	.113	.104	.256**	.318**	(-)						
7. Analog tool comprehensiveness	1.75	1.47	.157	.026	.004	.203*	.376**	.131	(-)					
8. Breadth of stakeholder involvement	9.50	4.33	.106	.085	.401**	-.029	.076	.123	.200*	(-)				
9. Depth of stakeholder involvement	2.69	1.95	-.019	.087	.656**	.001	.213*	.097	.166	.422**	(-)			
10. Digital tool comprehensiveness	.60	.92	.138	.069	-.002	-.029	.295**	.139	.399**	.040	.008	(-)		
11. IT supported formal management	1.97	.99	-.031	.034	.217*	.136	.386**	.392**	.315**	.247*	.369**	.189	(-)	
12. Implementation orientation	.028	.019	.029	.326**	-.007	-.064	.008	.017	.173	-.065	.150	.149	.181	(-)

S.D., standard deviation.

\* p &lt; .05, \*\* p &lt; .01, \*\*\* p &lt; .001 (two-tailed).

n=106

The *breadth of stakeholder involvement* was measured as the number of stakeholder groups who were relevant in the innovation process, rated by the respondents to be relevant for their specific urban innovation project. The respondents could choose between 22 different stakeholders and could add three further stakeholder groups who were not previously subject to the choice. These stakeholders originate in the relevant city's ecosystem (Freeman, 2010; Kastalli and Neely, 2013) and include businesses (e.g., energy providers, real estate companies, service providers), residents (e.g., citizens' groups, owners, tenants), academia (e.g., research institutes, universities), and government and utilities (e.g., non-profit associations, city government, national government).

The capturing of the *depth of stakeholder involvement* was based on the collaboration intensity of the aforesaid stakeholder groups during the urban innovation development process. The respondents were asked to evaluate the collaboration intensity of the relevant stakeholder groups during three different development phases (information generation, development of innovation alternatives, and decision on relevant innovation alternatives) on a five-point scale from 'no collaboration' to 'very intensive collaboration' (Heravi et al., 2015). The collaboration intensity of all three phases was summed for each stakeholder group and an average intensity was calculated for all involved stakeholder groups. A high average intensity indicates a greater depth of stakeholder involvement, while a low average intensity indicates a lesser depth of stakeholder involvement.

The capturing of the *comprehensiveness of used digital tools* for stakeholder involvement was based on four items. The survey respondents stated how intensively (on a five-point scale ranging from 'not used at all' to 'very intensively used') they used tools to involve stakeholders digitally (El-Gohary et al., 2006; Marion et al., 2014; Marion et al., 2016). The construct was calculated by counting the number of tools which were intensively used (with an average intensity per item above 3.5), ranging from zero to four tools per urban innovation project. The comprehensiveness of used digital tools was, among others, based on idea crowdsourcing and social media.

The *IT supported formal management level* was assessed with three items drawn from previous literature (White and Fortune, 2002; Teller et al., 2012; Mauerhoefer et al., 2017). The respondents evaluated their formal management based on the use intensity of IT instruments (e.g., IT platforms and planning tools).

We included several covariates in the model to exclude that the implementation orientation relies on the influence on other variables than the independent ones. The *content breadth* shows the content heterogeneity and extent of the urban innovation project. Therefore, the number of developed innovation alternatives were extracted from the written planning documents, and were summed afterwards, ranging from one to 57 developed innovation alternatives. The respondents stated the *district size* by reporting the number of inhabitants who were directly affected by the innovation alternatives created in the urban innovation project and who were included to control for the size of the ecosystem. The number of inhabitants were then included in the regression model as a continuous control variable. To control for the *stakeholder involvement experience* of the urban innovation project, we calculated a medium involvement intensity before the current project started (based on the respondents information for the relevant stakeholder groups), and included only those stakeholder groups in the measure who were relevant in these urban innovation projects (referring to the individual stakeholder groups per project). We control for the stakeholder involvement experience, because the stakeholder involvement experience may influence the implementation orientation, which is shown in previous literature (e.g., Yuan et al., 2014; Vaillant et al., 2019). The *project experience* indicates the professional level of the project team in urban restructuring by counting the number of similar projects, which the responding organization previously developed. We control for the project experience to ensure that the implementation orientation is not a result of a high project management experience. Innovativeness was used as a control variable to account for the projects' heterogeneity and to ensure that, for example, higher levels of innovativeness do not result in lower levels of implementation. Innovativeness was based on two factors that rely on the multidimensional innovation degree measurement used in the article of Schultz et al. (2013). The first construct (*organizational degree of innovativeness*) relies on five items that indicate the market newness of the innovation alternatives, the newness of the urban environment, and the impact of the innovation alternatives on the structures of the urban ecosystem, such as established communication channels. The second construct (*technological degree of innovativeness*) includes two items that show the technological newness of the urban innovation project and the extent to which the project content exceeds the funding guidelines. The *comprehensiveness of used analog tools* for stakeholder involvement was captured in a similar manner as the comprehensiveness of used digital tools. The survey respondents stated how intensively (on a five-point scale ranging from 'not used at all' to 'very intensively used') they used tools to personally involve

stakeholders (El-Gohary et al., 2006). Three tools only indicate stakeholder information (e.g., publish articles in daily press) instead of involvement, and were therefore excluded. The comprehensiveness of used analog tools was based on four items and was related to, for example, workshops and discussion rounds.

## Results

### Regression results

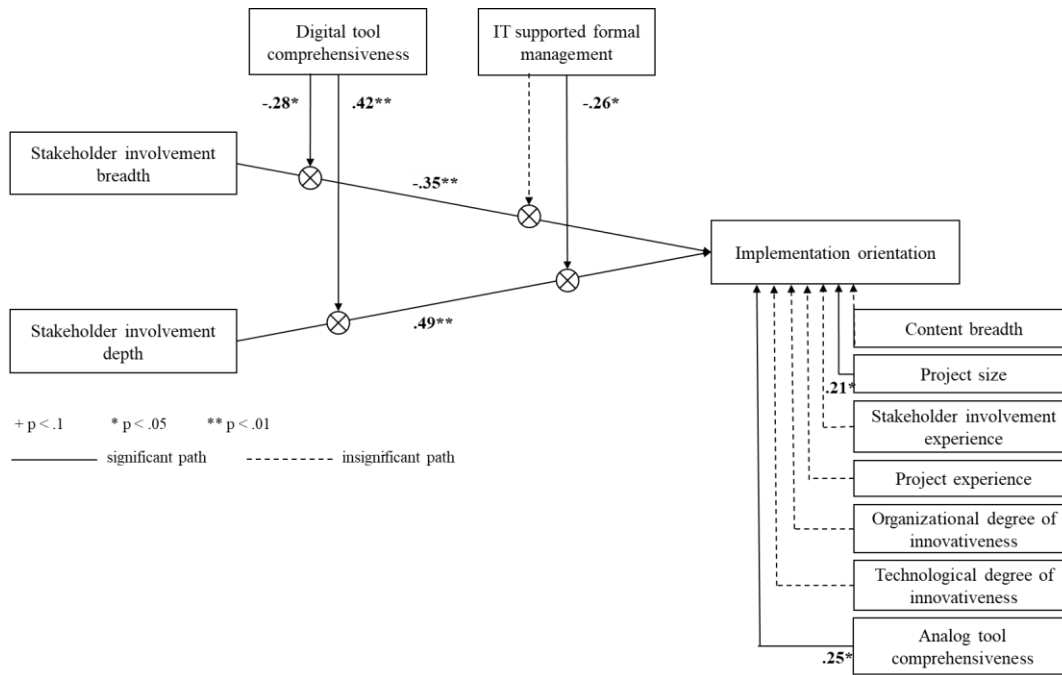
To test the hypotheses, we applied ordinary linear regression analysis, the results of which are summarized in Table 4. Model 1 shows the baseline model, Model 2 adds all independent variables to investigate the main effects, and Model 3 adds all interaction variables to investigate the moderation effects. We focus on the results of the model with the highest level of fit, Model 3 ( $R^2=.34$ ;  $F=3.12$ ). The regression results show that two of the covariates, district size and analog tool comprehensiveness, positively and significantly influence urban innovation projects' implementation orientation, while the other covariates do not significantly influence the implementation orientation. The regression results further reveal a significant and negative influence of the breadth of stakeholder involvement on the implementation orientation ( $\beta=-.35$ ;  $t=-3.24$ ;  $p\leq 0.01$ ), and a positive and significant influence of the depth of stakeholder involvement on the implementation orientation ( $\beta=.49$ ;  $t=3.45$ ;  $p\leq 0.001$ ), thereby supporting hypothesis 1a and 1b. The negative effect of a broad stakeholder involvement on the implementation orientation is strengthened by the comprehensive use of digital involvement tools, thus supporting hypothesis 2a ( $\beta=-.28$ ;  $t=-2.26$ ;  $p\leq 0.05$ ). Further, the negative effect of a broad stakeholder involvement on the implementation orientation is not weakened by a high level of IT supported formal management. Therefore, hypothesis 3a is not supported. Additionally, the positive effect of deep stakeholder involvement is strengthened by the higher level of comprehensiveness of used digital tools ( $\beta=.42$ ;  $t=3.37$ ;  $p\leq 0.001$ ), and weakened by a high level of IT supported project formalization ( $\beta=-.26$ ;  $t=-2.41$ ;  $p\leq 0.1$ ). Hypothesis 2b and 3b are thus supported. The effect size of the model, including all direct and moderating effects, is strong ( $f^2=.52$ ; Cohen, 1988). Figure 1 depicts the model and regression coefficients.

**Table 4. Regression results**

	Model 1			Model 2			Model 3		
	$\beta$	p	t	$\beta$	p	t	$\beta$	p	t
<i>Controls</i>									
Content breadth	-.04	.67	-.42	.00	.88	.15	.09	.37	.90
District size	<b>.33</b>	<b>.00</b>	<b>3.32</b>	<b>.29</b>	<b>.00</b>	<b>2.99</b>	<b>.21</b>	<b>.03</b>	<b>2.27</b>
Stakeholder involvement experience	-.02	.82	-.23	-.09	.46	-.74	-.17	.15	-1.46
Project experience	-.08	.43	-.80	-.10	.34	-.97	-.12	.21	-1.26
Organizational degree of innovativeness	.02	.87	.16	-.90	.45	-.76	-.15	.19	-1.34
Technological degree of innovativeness	-.03	.78	-.28	-.04	.71	-.37	-.00	.99	-.013
Analog tool comprehensiveness	<b>.18</b>	<b>.08</b>	<b>1.77</b>	.15	.19	1.32	<b>.25</b>	<b>.03</b>	<b>2.23</b>
<i>Predictors</i>									
Breadth of stakeholder involvement				<b>-.21</b>	<b>.06</b>	<b>-1.91</b>	<b>-.35</b>	<b>.00</b>	<b>-3.24</b>
Depth of stakeholder involvement				.21	.10	1.65	<b>.49</b>	<b>.00</b>	<b>3.45</b>
Digital tool comprehensiveness				.07	.49	.70	-.03	.76	-.30
IT supported formal management				.17	.14	1.48	<b>.25</b>	<b>.03</b>	<b>2.26</b>
<i>Moderation</i>									
Breadth of stakeholder involvement x Digital tool comprehensiveness							<b>-.28</b>	<b>.03</b>	<b>-2.26</b>
Depth of stakeholder involvement x Digital tool comprehensiveness							<b>.42</b>	<b>.00</b>	<b>3.37</b>
Breadth of stakeholder involvement x IT supported formal management							-.00	.99	-.01
Depth of stakeholder involvement x IT supported formal management							<b>-.26</b>	<b>.02</b>	<b>-2.41</b>
<b>R<sup>2</sup></b>		<b>.14</b>			<b>.22</b>			<b>.34</b>	
<b>Adjusted R<sup>2</sup></b>		<b>.08</b>			<b>.13</b>			<b>.23</b>	
<b><math>\Delta R^2</math></b>					<b>.08</b>			<b>.12</b>	
<b>f<sup>2</sup></b>		<b>.16</b>			<b>.28</b>			<b>.52</b>	
<b>F</b>		<b>2.34</b>			<b>2.36</b>			<b>3.12</b>	
<b><math>\Delta F</math></b>					<b>.02</b>			<b>.76</b>	

Dependent variable is implementation orientation; n=106; table contains standardized coefficients with p and t-values (two-tailed)



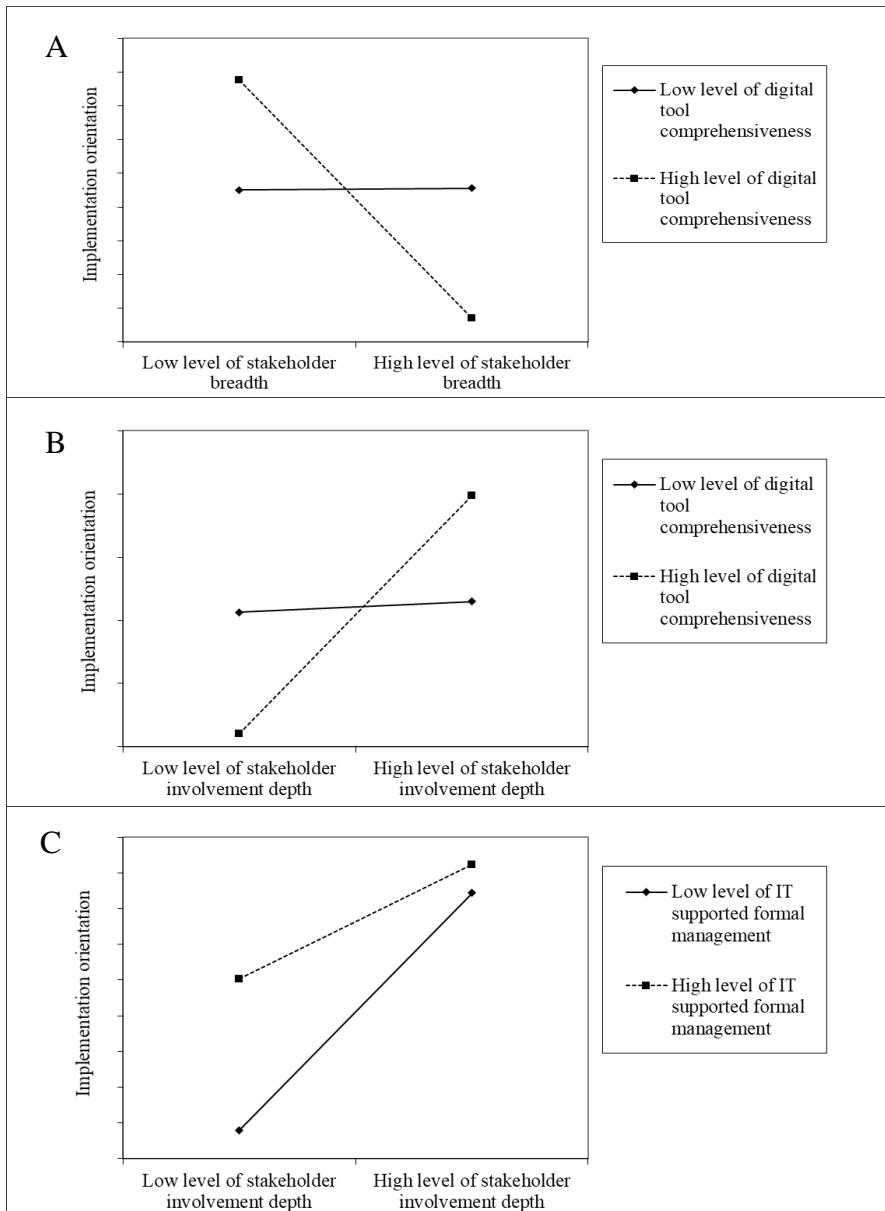


**Figure 1. Model and path coefficients**

**Moderation analysis**

Figure 2A indicates the effect of the breadth of stakeholder involvement intensity on the implementation intensity dependent on the level of comprehensiveness of used digital involvement tools like idea crowdsourcing. The plot shows the moderation effect in respect of a low level (mean minus -1S.D.) and a high level (mean plus +1S.D.) of digital tool comprehensiveness. The significant moderation effect illustrates that the relationship differs significantly between the low and high level of comprehensiveness of used digital tools. The complexity and coordination efforts of broad stakeholder involvement increase with the comprehensive use of digital tools, thereby resulting in a weak implementation orientation. Furthermore, Figure 2B graphically illustrates the effect of the depth of stakeholder involvement on the implementation orientation dependent on the level of the comprehensiveness of used digital tools. The results show that high digital tool comprehensiveness strengthens the influence of stakeholder involvement depth on the implementation orientation. Without the use of digital tools, the intensive collaboration with stakeholders has no effect on the implementation orientation. Figure 2C illustrates the effect of the depth of stakeholder involvement on the implementation orientation dependent on the level of IT supported project formalization. For high levels of IT supported formal management, the relationship between stakeholder involvement depth and implementation

orientation becomes weaker. However, the results also show that in the case of urban innovation projects with a low depth of stakeholder involvement, a high proficiency of internal information processing and coordination could partly compensate the neglected benefits of external stakeholder information.



**Figure 2. Plots of the moderation effects**

## Discussion

Urban innovation projects depend on stakeholder involvement. In this context, this study provides additional insight into the current discussion on whether intensive stakeholder involvement fosters innovation success (e.g., Garcia-Castro and Francoeur, 2016). We conclude that while a high measure of stakeholder breadth negatively influences the urban innovation's implementation orientation, the implementation orientation is positively influenced by deep stakeholder involvement. This is in line with previous literature that highlights the importance of stakeholder involvement in complex innovation processes (e.g., Katz, 2006; Juntunen et al., 2019). The results also show that stakeholder involvement reduces urban innovation's uncertainty (e.g., Nielsen et al., 2019). Nevertheless, information processing requirements increase with the number of stakeholders, thereby resulting in a lower performance. A broad stakeholder involvement could lead to a mismatch between the project team's information processing capability and the information processing requirements (Turkulainen et al., 2015). Urban innovation project teams struggle to resolve this mismatch because of their limited time horizon to establish necessary organizational routines. Stakeholder coordination and prioritization thus become a main success factor in complex urban innovation projects. This finding is in line with current research that shows that information processing capability increases the new product performance of complex innovation projects (Ahmad et al., 2013).

Our research results indicate that involvement tools in general increase the knowledge base and thereby reduce ecosystem uncertainty, because the comprehensive use of analog and digital tools strengthens the implementation orientation. This is especially true for the comprehensive use of digital tools, as suggested in more recent literature (e.g., Waters et al., 2009; Marion et al., 2016). The comprehensive use of digital tools enhances the influence of stakeholder involvement depth on the implementation orientation. The extensive use of digital tools thus encourages stakeholders to participate in urban innovation implementation and fosters stakeholder acceptance, resulting in a stronger implementation orientation. Stakeholder breadth's complexity is, in contrast, further increased by the comprehensive use of digital tools, which is supported by the negative and significant moderation effect. Stakeholders who are more skeptical tend to use these low-threshold digital tools to level criticism, thereby fostering public opposition that can hamper urban innovation implementation (e.g., Cuppen et al., 2016; Liu et al., 2018). This could upset other stakeholders who, as a result, might hesitate to implement innovations.

Additionally, since the project team must mediate between conflicting goals, it could waste important implementation resources.

Furthermore, the results underline the importance of IT for information processing in complex innovation projects (e.g., Dias et al., 2014; Peng et al., 2014; Mauerhoefer et al., 2017), specifically because IT supported formal management has a direct and positive effect on the implementation orientation. This is in line with project management literature (e.g., Gann and Salter, 2000; Davies and Hobday, 2005). Nevertheless, too tight structures hamper the positive influence of stakeholder involvement depth on the implementation orientation. A high level of IT supported formalization impedes flexible and agile involvement processes and can decrease the project team's capacity to absorb heterogeneous stakeholders' needs (Lane and Lubatkin, 1998; Kavanagh and Naughton, 2009). Surprisingly, IT supported formal management does not assist in coping with stakeholder breadth' complexity, as the moderation shows no significant influence. This is contrary to project management literature (e.g., Dos Santos et al., 2008; Richtnér et al., 2008). The restricted project time horizon of the urban innovation project team seems to be too short to install efficient internal information processing capabilities (e.g., Sydow and Braun, 2018; Hadida et al., 2019).

Our results contribute to the current literature on stakeholder involvement capabilities by showing that external and internal information processing capabilities are necessary for stakeholder involvement (e.g., Driessen and Hillebrand, 2013; Watson et al., 2018). Therefore, we recommend that stakeholder and tool prioritization is necessary to reduce the complexity inherent to large numbers of stakeholder groups and available digital tools for stakeholder involvement and formal management.

## **Implications and limitations**

### **Theoretical implications**

This research is based on instrumental stakeholder theory (Donaldson and Preston, 1995; Jones et al., 2018) and information processing theory (Galbraith, 1974; Tushman and Nadler, 1978), and it introduces stakeholder information processing capability as a mean to benefit from stakeholder involvement in urban innovation project performance. Digital tools that gather stakeholder information and IT based formal management tools that structure and process the information in the project team, shape this stakeholder

information processing capability. Furthermore, this study extends stakeholder and innovation management literature by investigating stakeholder involvement as a two-edged sword: While intensively involving a few stakeholder groups yields positive performance effects, broad stakeholder involvement decreases innovation performance. Thus, the combination of both theoretical frameworks shows the boundaries of stakeholder information processing and reveals how to overcome information processing obstacles by using digital tools.

We extend existing research on urban innovation management, which was mainly published in public governance and urban planning literature, even though the practical relevance of the research on urban innovation is high. For example, there is a dire need for urban innovations to develop sustainable cities and communities as suggested by the Sustainable Development Goals of the United Nations. We thus respond and contribute to the call for research on the mechanisms which underlie these complex innovation processes and how to achieve urban transformation (e.g., Da Silva et al., 2019).

Innovation implementation is a major success factor in urban innovation, although it is difficult to measure. This article introduces a more fine-grained measure to account for the implementation orientation, which is extracted from concrete urban innovation planning documents. Implementation orientation was measured based on text mining, following a sentiment analysis, and the study thus provides proof of the applicability of text-based measures in empirical studies and innovation management research (Meyer et al., 2008). The combination of survey and text mining data helps to overcome common-method bias and externally validates the results.

### **Managerial implications**

Based on the proposed and empirically tested model, several recommendations are made that can serve (project) managers. First, regarding the limited time horizon of urban innovation projects, managers should conduct a detailed stakeholder analysis based on predefined criteria to identify those stakeholders who have the most ecosystem knowledge and who can increase the project team's knowledge base. Because of the negative influence of stakeholder breadth on the implementation orientation, stakeholder portfolio management is recommended. Second, managers should use a broad set of digital involvement tools, including crowdsourcing and social media, to interact with

stakeholders. This proposal is in line with the need for a moderate level of formalization. The comprehensive use of digital involvement tools eases flexible and agile stakeholder interaction, thereby positively influencing the strength of the implementation orientation. Third, managers should regulate the use of formal management methods and tools, and should keep the level of formalization at a moderate level for stakeholder involvement in order to ensure flexible and agile stakeholder interaction and to sustain the ability to process the information they receive from the stakeholders.

### **Limitations**

Despite its contributions, this study has certain limitations that must be considered. Although the model contains covariates, further covariates may be required to explain more of the predicted variable's variance. Additional moderating variables can also be included in the model. Additionally, the effect of stakeholder involvement breadth and depth may be partly mediated by variables that were not included in our model.

Although the measure of stakeholder involvement depth accounts for the involvement of stakeholders during each of the development phases, it would be interesting to see how the actual implementation evolves over time. So far, the depth of stakeholder involvement accounts for all stakeholder groups, independently of a stakeholder analysis based on criteria like stakeholder legitimacy, normative cores, and their attitude toward the urban innovation project (e.g., Phillips, 2003). Future research should investigate the influence of distinguished stakeholder groups on innovation implementation.

The study's sample size included only 106 German urban innovation projects. Future research could extend the sample size and include urban innovation projects that are not implemented in but also beyond Germany.

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**Appendix 1. Word roots to measure the implementation orientation**

The wildcard '*' can represent any characters. Word roots were translated from German; complete word list contains additional synonyms				
begin*	compl*	conduct*	implement*	install*
plan*	practic*	proc*	progr*	real*
reconstruct*	redevelop*	run*	settl*	transform*
appl*				

## Appendix 2. Measures and corresponding factor loadings

Construct	Items	Factor loading
<b>Degree of IT supported formal management</b>	( $\alpha=.809$ ) (1=strongly disagree, 5=strongly agree)	
	We used specific software to support our project management.	.876
	We intensively used IT platforms (databases, clouds, and wikis) to save and share our knowledge.	.801
	We used IT based planning tools like GANTT to visualize and save our project management and resource availability.	.831
<b>Digital tool comprehensiveness</b>	( $\alpha=.781$ ) (1=strongly disagree, 5=strongly agree)	
	We worked together with stakeholders through online tools like social media and idea crowdsourcing platforms.	.706
	We published our project management and our developed innovation alternatives in the internet so that all stakeholders can easily access and discuss our results.	.580
	We created social media profiles to keep stakeholders up to date on the progress of urban innovation implementation and to give them the opportunity to contact us via such channels.	.918
	We opened an online forum, where stakeholders could add further innovation ideas.	.961
<b>Analog tool comprehensiveness</b>	( $\alpha=.791$ ) (1=strongly disagree, 5=strongly agree)	
	We used discussion rounds to gain new ideas for urban innovation development.	.754
	We did interactive events like workshops to take new perspectives and to interpret well-known information against a new background.	.881
	We discussed our developed innovation alternatives in workshops with regard to implementation.	.832
	We intensified our cooperation in the project team through collaborative events like workshops.	.601
<b>Organizational degree of innovativeness</b>	( $\alpha=.765$ ) (1=strongly disagree, 5=strongly agree)	
	We established a new 'we-feeling' with our urban innovation project in the city district.	.732
	We reached heterogeneous stakeholder groups like residents, small and medium-sized firms, the by developing urban innovation alternatives.	.690
	We established new ways of communication in the city district that will be used in future.	.835
	We as an organization built up contact to other organizations that we will we use after the urban innovation project.	.744
	Our organization built up new knowledge that will change our processes and standards internally because of the urban innovation project.	.522
<b>Technological degree of innovativeness</b>	( $\alpha=.624$ ) (1=strongly disagree, 5=strongly agree)	
	The content of our urban innovation project exceeds the funding guidelines substantially.	.840
	We developed technologically new products and system innovations in our urban innovation project.	.814

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## **Paper 4: Cooperating with the opposition: The influence of skeptical stakeholder involvement on urban innovation projects' innovativeness and implementation**

Julia Kroh; Carsten Schultz

### **Abstract**

Urban renewal is increasing in relevance, mainly due to the need to address climate change. In pursuit of this goal, urban innovations target the development and implementation of collectively used infrastructures and resources in cities. Smart city solutions and innovative district heating grids in a city neighborhood – as examples of these innovations – at the same time face the opposition of both skeptical and powerful private and public stakeholders. Despite the importance of stakeholder involvement in complex innovation projects, past research largely neglected the influence of stakeholders who have a negative opinion of an innovation project. These skeptical stakeholders become more prominent when the degree of innovativeness of cross-organizational projects increases. They may change the scope of, delay, or even entirely block the projects. On the contrary, because of their diverse knowledge and perspectives, these skeptical stakeholders might benefit innovation projects. Urban innovation projects are well-suited to explore these relationships. Not only do they target the development and implementation of innovations in an open and inclusive collaborative ecosystem, but they include all city stakeholders representing local government, businesses, research institutes, civil societies, and citizens. Our research draws on stakeholder theory, as well as on innovation and project management literature to investigate the impact of the involvement of skeptical stakeholders on the innovativeness, the implementation orientation, and the implementation status of urban innovation projects. Further, based on a study of 107 German innovation projects for energy efficiency improvements in urban districts, we analyze the management capabilities that increase the intensity of skeptical stakeholder involvement in these projects. The results rely on a unique combination of research methods. This includes the analysis and text mining of the written planning documents to assess the innovativeness and the implementation orientation of the projects, the analysis of websites and online-published newspaper articles to assess the implementation status of the projects, and the use of survey data to assess the management capabilities of the project teams and the nature of stakeholder involvement. The results provide empirical evidence

(i) that the involvement of skeptical stakeholders positively influences project innovativeness and implementation orientation, and (ii) that high resource availability and moderate degrees of formal management increase the intensity of skeptical stakeholder involvement.

Keywords: Stakeholder management; stakeholder involvement; stakeholder attitude; innovativeness; innovation implementation; complex innovation project; temporary organization; urban innovation

*It ought to be remembered that there is nothing more difficult to take in hand, more perilous to conduct, or more uncertain in its success, than to take the lead in the introduction of a new order of things. Because the innovator has for enemies all those who have done well under the old conditions, and lukewarm defenders in those who may do well under the new. This coolness arises partly from fear of the opponents, who have the laws on their side, and partly from the incredulity of men, who do not readily believe in new things until they have had a long experience of them.*

Niccolo Machiavelli (1513), from ‘The Prince’

## **Introduction**

To account for the future ecological needs of cities and to reduce climate change, innovation development in the urban space is becoming more relevant (Joss, 2015). Contrary to the required goal of increasing energy efficiency and reducing carbon emissions, more urbanization actually increases the already high energy and resource consumption rates in cities (e.g., Dente and Colletti, 2011; Mieg, 2012). In pursuit of this goal, urban innovations target the development and implementation of collectively used infrastructures and resources in cities and are thus in high demand (Koop and van Leeuwen, 2017; Appio et al., 2019; Nilssen, 2019). As a result, urban innovation projects in small and medium-sized cities are as important as large urban development projects. We focus on urban innovations in the field of the renewal of existing urban ecosystems in the districts of small, medium-sized, and large cities in Germany. These urban innovation projects develop planning documents and rely on novel ways of stakeholder engagement to develop and implement system innovations.

Smart city solutions and innovative district heating grids in a city neighborhood – as examples of these innovations – simultaneously face opposition from both skeptical and powerful private and public stakeholders, and thus require new and collaborative stakeholder management approaches (e.g., Kornberger et al., 2017; Mora et al., 2019; Silva et al., 2019). For example, one of our analyzed cases, a township with about 7,000 inhabitants in the north of Germany, was awarded several innovation awards for its urban innovation project. They developed a concept to store solar energy and the heat loss of a small firm during the summer, and to use it to heat the township during winter. The heat storage, a 40,000 m<sup>3</sup> underground tank, is unique to Germany. Furthermore, the project team helped to establish a municipal non-profit operating company, in which private stakeholders like residents could join, responsible for the implementation and operation of the system. This is unusual, because for-profit oriented firms like energy suppliers are mainly responsible for heating infrastructure, as it was the case in another study where the

local energy supplier operates a thermal power station owned by the residents, and demands private individuals and firms to make substantial behavior changes, thereby producing unpredictable stakeholder reactions like opposition. Nevertheless, one of the project team members explained that urban innovation can benefit from the resistance against such behavioral changes:

*We have to involve the skeptical stakeholders, those that always ask how much they have to pay and how they will profit from the innovation. At least, these stakeholders take a position and this is where you can start talking, collaborating, and generating advantages for both sides. They may be skeptical at the beginning, but they know what they want and the consideration of these requirements often leads to project success.*

Despite the crucial importance of stakeholder involvement in complex innovation projects, as confirmed by the example, past research largely neglected the influence of stakeholders who have a negative opinion of an innovation project. Because of the high complexity of, the initial investments in, and the substantial behavior changes required by the project, the relevant stakeholder groups tend to be skeptical about this type of innovation, and their skepticism increases with higher degrees of innovativeness (hereinafter referred to as *higher innovativeness*) (Whitmarsh and Nykvist, 2008). Hence the stakeholders' attitude, namely the position adopted by the stakeholders on a project (Winch and Bonke, 2002; Olander, 2007), is an important factor in large-scale mega projects like shale gas explorations (Cuppen et al., 2016), major construction projects (Liu et al., 2018), and public infrastructure projects (e.g., Di Maddaloni and Davis, 2017; Mok et al., 2017; Yu et al., 2017). Therefore, developing and implementing innovations in conjunction with skeptical stakeholders is a key determinant of the success of urban innovation projects (e.g., Dente et al., 2005). In response, the objective of this research is to investigate the influence of skeptical stakeholder involvement on the success of urban innovation projects and the project team capabilities that facilitate collaboration with these stakeholder groups.

The impact of the involvement of skeptical stakeholders in temporary organizations is not clear. On the one hand, their involvement could negatively impact on efficiency and efficacy (e.g., Bengtsson et al., 2015). Their involvement may change the scope of the projects, delay, or even entirely block projects. Although the city is a fuzzy ecosystem, its stakeholders, like its government and residents, are often highly institutionalized and thus bound to tight structures and routines (e.g., Pipan and Porsander, 2000). By nature, stakeholders fear change and are skeptical about all activities representing change (March



and Simon, 1958). Accordingly, implementing innovations to achieve urban development will face resistance and skeptical stakeholders are likely to defend the status quo (Landry, 2012). On the other hand, because they articulate their claims and challenge existing standards (e.g., Hall and Martin, 2005; Watson et al., 2018), skeptical stakeholders are a source of constructive feedback (Hauschildt, 1999; Markham, 2000; Elias, 2016; Juntunen et al., 2019). Drawing on instrumental stakeholder theory (e.g., Jones et al., 2018), temporary organizations that apply stakeholder attitude as a prioritization criterion can increase their performance by involving rather than ignoring skeptical stakeholders. They could benefit from the diverse and tacit knowledge of the urban ecosystems' heterogeneous actors, like private owners, industries, and public institutions, which not only interact in complex and non-linear ways (Cozijnsen et al., 2000; Katz, 2006; Bogers et al., 2016) but are also able to develop highly innovative solutions (Caragliu et al., 2016). Furthermore, the involvement of skeptical stakeholders can increase overall innovation acceptance and result in higher implementation rates (Olsen et al., 2016; Grimpe et al., 2019; Lindkvist et al., 2019). Nevertheless, the role of skeptical stakeholder involvement for innovation success is not clarified in project and innovation management literature and, at present, existing research is qualitative rather than quantitative (e.g., Yang, 2014; Opong et al., 2017). We therefore quantitatively investigate the influence of skeptical stakeholder involvement on three urban innovation success measures (the innovativeness, the implementation orientation in written urban innovation planning documents, and the current implementation status of the projects) to account for urban innovations' ambidextrous goals. This leads to the study's first research question: *How does skeptical stakeholder involvement influence urban innovation projects' innovativeness, their implementation orientation, and their implementation status?*

The involvement of skeptical stakeholders, in particular, is challenging since their involvement may require specific project management capabilities (e.g., Uribe et al., 2018). More specifically, formal project management capabilities and the ability to promote high quality teamwork through informal management approaches play important roles. The development of urban innovation alternatives needs intensive communication and coordination within the project team (e.g., Hoegl and Gemuenden, 2001) and within the entire stakeholder ecosystem, and necessitates well-structured formal management with adequate resources to cope with these demanding stakeholders (e.g., Dente et al., 2005). Formal management methods can facilitate stakeholder coordination, but they could also

hamper the absorption of the contributions of skeptical stakeholders, mainly because it is impossible to handle heterogeneous and potentially inconsistent information when processes are too narrowly defined (Aggeri and Segrestin, 2007; Kavanagh and Naughton, 2009). Given the complex nature of skeptical stakeholder involvement, the second research question is: *How can a project team facilitate skeptical stakeholder involvement?*

To answer the two research questions, this study relies on a unique combination of text mining, text analysis, online desk research, and survey data drawn from a data set based on 107 publicly funded, urban innovation initiatives in Germany. We thus contribute to instrumental stakeholder theory and innovation management practice by indicating that stakeholders' attitude is a relevant decision criterion of stakeholder prioritization (e.g., Driessen and Hillebrand, 2013) in complex innovation processes, and by providing insights into relevant management capabilities for skeptical stakeholder involvement. We also respond and contribute to the call for neighborhood and city-centric research (Wachsmuth et al., 2016), and for the clarification of stakeholder management mechanisms in urban development (Paroutis et al., 2014; Appio et al., 2019).

## **Conceptual background and hypotheses development**

### **The role of stakeholders in complex innovation projects**

Stakeholder theory suggests that stakeholder involvement positively influences an organization's performance, its competitive advantage (e.g., Freeman, 2010; Harrison et al., 2010), and its innovation performance (Flammer and Kacperczyk, 2016; Li et al., 2018). To the extent that it differs from an organization's innovation process, innovation development in complex innovation projects, such as the urban ecosystem, influences the more heterogeneous stakeholder groups that must collaborate to achieve a high innovation performance (De Laurentis, 2006; Garud et al., 2011; Kazadi et al., 2016). In innovation management literature, these complex innovation projects are often described as temporary organizations created to develop and implement innovations (Lundin and Soederholm, 1995; Schreyoegg and Sydow, 2010; Sydow and Braun, 2018). Their complexity arises from their main characteristics, namely temporariness, uniqueness, heterogeneity (disciplines involved, personnel, work contents), and lack of organizational routines (Geraldi et al., 2011; Hanisch and Wald, 2011). For example, the increase in the number of relevant stakeholders and their interdependence results in an increasing demand for

coordination, information, and information processing (Sommer and Loch, 2004; Pauget and Wald, 2013). Considering a limited time horizon, professional experience in the areas of urban innovation projects can ease collaboration (Hadida et al., 2019).

Recent project management literature shows that many innovation projects disregard stakeholder differentiation and management (e.g., Mok et al., 2015), even though the anticipation of potential stakeholder reactions is a critical factor in temporary organizations (Hall and Martin, 2005). Stakeholder prioritization, depending on their relative influence, legitimacy, and urgency regarding a project, is crucial for successful stakeholder management (Mitchell et al., 1997; Eesley and Lenox, 2006; Davis, 2014; Weitzner and Deutsch, 2015), and for the identification of stakeholders' position on the project (McElroy and Mills, 2000; Winch and Bonke, 2002; Olander, 2007). While stakeholders' legitimacy is one of the main criteria of stakeholder analysis (e.g., Mitchell et al., 1997), the influence of the position of legitimated stakeholders on an innovation has not, to the best of our knowledge, been empirically tested. Innovation management literature, particularly, lacks quantitative studies on the influence of skeptical stakeholders. Some articles nevertheless introduced innovation champions or promoters as individuals who encourage innovation development, as well as their counterparts, namely the antagonists or rivals who form the relevant opposition within innovation processes (e.g., Hauschildt, 1999; Markham, 2000). Table 1 provides an overview of the different skeptical stakeholder concepts that appear in project, stakeholder, and innovation management literature.

**Table 1. Overview of literature on skeptical stakeholder concepts**

Literature stream	Concept	Research focus	Exemplary studies	Implications
<b>Innovation management</b>	Antagonism / opposition	Research on the individual role (terms used synonymously) that represents the counterpoint to the innovation champion; focus on their behavior and implications	Chakrabarti and Hauschildt, 1989 Markham et al., 1991 Hauschildt, 1999 Markham, 2000 Walter et al., 2011	Champions and antagonist coexist, although opposition is a rare resource in innovation; antagonist test, but do not harm champions' thinking, thereby increasing the quality of innovations
<b>Innovation management</b>	Innovation resistance / opposition	Active and passive opposition as the strongest form of innovation resistance besides postponement and innovation rejection; research on reasons for innovation resistance and differences between active and passive opposition / resistance	Szmigin and Foxall, 1998 Laukkanen et al., 2008 Kleijnen et al., 2009 Talke and Heidenreich, 2014 Heidenreich and Kraemer, 2016	Opposition relies on resistance to changes caused by an innovation; perceived relative disadvantage driven by adopter-specific norms; passive opposition appears in the innovation development phase, while active opposition is based on negative experiences; the design of innovations should be flexible, to fit opponents' requirements
<b>Project management</b>	Negative position / attitude	Focused on practice-based stakeholder analysis; identification of stakeholders who have a negative attitude toward a project / an innovation; how to manage stakeholders and their conflicts	Winch and Bonke, 2002 Olander, 2007 Aaltonen et al., 2015 Di Maddaloni and Davies, 2017 Liu et al., 2018 Yu et al., 2019	Toolbox for stakeholder management Identify stakeholders' position and motivate salient and negative-positioned stakeholders to participate
<b>Stakeholder management</b>	Influence of stakeholders and shareholders	Research based on instrumental stakeholder theory; investigates the influence of different internal and external stakeholders on performance measures like financial performance and innovativeness	Julian et al., 2008 Bridoux and Stoelhorst, 2014 Su and Tsang, 2015 Desai, 2018 Zhao et al., 2017 Grimpe et al., 2019	Stakeholder involvement leads to increases in performance dependent on the stakeholder group and environmental conditions like technology turbulence

The more complex an innovation project, the higher stakeholders' perceived innovation barriers and, subsequently, their skepticism and potential resistance (Hueske and Guenther, 2015; Mani and Chouk, 2018). The reason is that innovations' complexity requires high magnitudes of change, resulting in high levels of risk (e.g., financial, social, and functional) (Kleijnen et al., 2009; D'Este et al., 2012). Skepticism generally describes the tendency of a stakeholder to disbelieve, doubt, question, or suspend a judgment (e.g., Bunge, 1991; Banikema and Roux, 2014). Skeptical stakeholders may trigger opposition and political interference (Clarkson, 1995; Harrison and St. John, 1996), and could thus be a highly influential cause of innovation resistance (e.g., Mani and Chouk, 2018). Because it involves a large number of public and private stakeholders, a temporary organization in an urban ecosystem necessarily includes stakeholders who are skeptical. Stakeholder groups with a negative attitude can decelerate the whole process (e.g., Fineman and Clark, 1996; Waligo et al., 2014; Fliaster and Kolloch, 2017). If the number of these stakeholders increase, so will the coordination needs, uncertainty, and management efforts (Luetjen et al., 2019). Skeptical and powerful stakeholders, particularly, will try to influence innovation activities and they could force a project team to reduce the scope and uniqueness of the proposed innovation alternatives. Therefore, the presence of skeptical stakeholders whose goals differ significantly from those of other stakeholder groups can compromise efficiency and efficacy (e.g., Hauschildt, 1999), and, since increased coordination efforts are required, lead to a decrease in innovativeness (e.g., Brody, 2003; Bengtsson et al., 2015).

Nevertheless, intensive collaboration with skeptical stakeholders who have an extremely negative disposition toward the innovation project can overcome the perceived barriers because, drawing on instrumental stakeholder theory, reciprocal coordination and knowledge sharing among stakeholders increase, resulting in greater motivation and a decrease in transaction costs (Jones et al., 2018; Juntunen et al., 2019). Frequent contact and interactions facilitate the development of shared norms, values, and goals regarding the content as well as the engagement process (Ruehli et al., 2017; Zhang et al., 2018). The deeper the collaboration, the more intensive the knowledge exchange, the greater the stakeholders' acceptance, and as a result, the lower the costs of additional information exchange and the larger eventual innovation implementation (e.g., Byrd, 2007; Da Silva et al., 2019). The identification and involvement of key stakeholders, like advocacy groups, foster the development of innovations in temporary organizations, because of their deep

knowledge of specific needs and their connections with a broad range of stakeholders (Olsen et al., 2016). Proper and frequent collaboration with skeptical stakeholders therefore increases the likelihood of more satisfied and engaged stakeholders (Yang et al., 2009; Eskerod et al., 2015).

### **Influence of stakeholders' position to a project**

Innovativeness is a common measure to evaluate the performance of innovation projects and it accounts for future ecological, economical, and social needs in the urban ecosystem (e.g., Joss, 2015). Innovativeness can be increased by an external search for information (e.g., Laursen and Salter, 2006). An organization that collaborates with potential skeptical stakeholders from policy and competition produces knowledge spillovers that subsequently result in new products and services (Mowery et al., 1998; Li et al., 2018; Adomako et al., 2019), and in the endorsement of goals (Williams et al., 2019).

However, past literature provides no clear evidence whether skeptical stakeholder groups should be involved in innovation processes (e.g., Karlsen, 2002). Opposition to innovation processes is seldom researched (see Table 1). However, in complex settings like temporary organizations, constructive opposition reduces stakeholder conflicts, thereby increasing project efficiency (Elias, 2016). Therefore, skepticism is a source of innovative ideas (Hauschildt, 1999; Roome and Wijen, 2006), and it increases the quality of innovations by broadening the knowledge base of innovation development (Juntunen et al., 2019) and challenging innovation alternatives (Markham, 2000). Collaboration with skeptical stakeholders can thus provide invaluable insights and frame issues solvable in ways that are technically feasible, politically acceptable, and beneficial to the common good (Bryson, 2004). The involvement of skeptical stakeholders can result in highly innovative solutions, which also change existing standards. Furthermore, the involvement of skeptical opinion leaders, like advocacy groups, has a signaling effect on other stakeholder groups as they emphasize the importance of the project, thereby increasing overall stakeholder acceptance and engagement (Van Eck et al., 2011; Wang et al., 2014; Olsen et al., 2016; Fliaster and Kolloch, 2017). Therefore, we assume that skeptical stakeholder involvement encourages innovative innovation development in temporary organizations.

*Hypothesis 1a: Skeptical stakeholder involvement positively influences the innovativeness of urban innovation projects.*

Against the backdrop of the stakeholder ecosystem's complexity and the associated long time horizon of urban innovation implementation, implementation becomes a desirable outcome and performance measure (e.g., Lindkvist et al., 2019). Only if innovative solutions are implemented in urban districts, the urban development will be successful. The involvement of skeptical stakeholders in innovation development enhances innovation implementation for several reasons. This collaboration builds trust between the stakeholders and the project team, thereby increasing the acceptance of the project and the willingness to implement innovations (Sloan and Oliver, 2013; Pinkse et al., 2014). This protects the project against the potential negative reactions of the skeptical stakeholders, especially when they are dissatisfied with the innovation alternatives (e.g., Dufour et al., 2019). Furthermore, if skeptical stakeholders are convinced by the innovation alternatives, they can serve as multipliers and orchestrators who encourage other stakeholders to implement these innovations (e.g., Reypens et al., 2019). Therefore, we assume that skeptical stakeholder involvement has a positive effect on urban innovation implementation. We distinguish two measures of urban innovation implementation, the implementation orientation and the current implementation status, because of urban innovations' long implementation horizon. The project team must focus on the implementation of innovation alternatives in the early phases of the innovation development, as high innovativeness and implementation may contradict each other. This is indicated by the implementation orientation. The current implementation status indicates how many of the before developed innovation alternatives reach implementation and shows the stage of the sustainable urban transformation. We state that skeptical stakeholder involvement positively influences both the implementation orientation of the project team and the implementation status.

*Hypothesis 1b: Skeptical stakeholder involvement positively influences the implementation orientation of urban innovation project.*

*Hypothesis 1c: Skeptical stakeholder involvement positively influences the implementation status of urban innovation project.*

**Capabilities that encourage skeptical stakeholder involvement**

The complex structures, vague responsibilities, and uncertain local acceptance that characterize the urban ecosystem require management capabilities on the part of the temporary organization in order to successfully involve skeptical stakeholders (Driessen and Hillebrand, 2013; Hillebrand et al., 2015). Recent research confirms that stakeholder information accessibility and quality (Waligo et al., 2014; Pera et al., 2016), knowledge management and transfer (Kazadi et al., 2016), and professional coordination mechanisms (Driessen and Hillebrand, 2013) are relevant. Thus, to generate innovative urban innovation alternatives, only a well-equipped, qualified, and coordinated project team can benefit from stakeholders' input. Several empirical studies emphasize the positive influence of informal characteristics, like teamwork quality (e.g., Yang et al., 2011), and formal management methods (e.g., Munns and Bjeirmi, 1996; Mir and Pinnington, 2014) on the overall project success, that is on the ability to comply with the specified time, budget, and content goals. Table 2 summarizes these stakeholder involvement capabilities. Based on quantitative data, our study contributes to this line of research by investigating the influence of the involvement capabilities of skeptical stakeholders.

Resource availability is one of the main success factors in project management (e.g., Belassi and Tukel, 1996). For example, a limited personnel and financial budget hampers the progress and completion of projects. Involving skeptical stakeholders may require more resources, as they challenge the existing beliefs of the project team. A project team must be equipped with more personnel with more diverse professional backgrounds, to account for all the stakeholders' requirements and to complete the urban innovation project. Urban innovation projects with more available resources are thus expected to involve skeptical stakeholders on a more intensive basis.

High quality teamwork indicates a high knowledge processing capability that, for example, is expressed through clear communication within the team (e.g., Haas, 2006). Additionally, a clear allocation of tasks and responsibilities facilitates the exploitation of synergies and the avoidance of inefficiencies in stakeholder involvement. An open and goal-oriented project team culture further promotes stakeholder involvement mechanisms and eases skeptical stakeholder involvement (e.g., Hoegl and Gemuenden, 2001).

*Hypothesis 2: A project team that has (a) access to an extensive resource base and (b) high quality teamwork will involve skeptical stakeholders more intensively.*



**Table 2. Overview of research on stakeholder involvement capabilities**

Article	Focused stakeholder group	Research question	Research method	Identified capabilities
<b>Behnam et al., 2018</b>	External stakeholders	Which specific business capabilities for involving external stakeholders does the development of sustainable innovations require?	Qualitative multiple case study	<ul style="list-style-type: none"> <li>• Networking and competence mapping</li> <li>• Relational (e.g., building trust-based relationships) and desorptive capabilities (the ability of aligning/empowering internals for external acquirements) that require reconciliation with the sustainability context</li> </ul>
<b>Driessen and Hillebrand, 2013</b>	Multiple market and nonmarket stakeholders	Which elements does stakeholder involvement in new (ecological) product development consist of?	Qualitative multiple case study	<ul style="list-style-type: none"> <li>• Stakeholder involvement capability as the combination of stakeholder issue identification techniques, coordination mechanisms, and prioritization principles</li> <li>• Result of a learning process; identification techniques support coordination mechanisms and prioritization principles</li> </ul>
<b>Kazadi et al., 2016</b>	Multiple internal and external stakeholders	Which capabilities do firms need to co-create innovations with multiple stakeholders?	Exploratory case study	<ul style="list-style-type: none"> <li>• Pre-project capabilities like stakeholder networking capability and stakeholder competence mapping</li> <li>• In-project capabilities like stakeholder relational capability and stakeholder knowledge management capability</li> </ul>
<b>Vaquero Martín et al., 2016</b>	External stakeholders	Which are the drivers of new product development processes and which capabilities do firms need for successful stakeholder involvement?	Systematic literature review	<ul style="list-style-type: none"> <li>• Push- and pull-factors drive stakeholder involvement</li> <li>• Stakeholder involvement capability relies on stakeholder identification capability, stakeholder interaction capability, and stakeholder input integration capability</li> </ul>
<b>Pera et al., 2016</b>	Multiple stakeholders beyond the customer	Which motives do stakeholders have to co-create and which practices lead to value co-creation in an ecosystem?	Qualitative single case study	<ul style="list-style-type: none"> <li>• Resource integration (based on communication, open platforms, and implementation support) essential for multi-stakeholder co-creation</li> <li>• Depends on individual stakeholder motives and characteristics</li> </ul>
<b>Waligo et al., 2014</b>	Multiple stakeholders in a sustainability project	How can organizations balance stakeholder and organization goals? Which influence does stakeholder participation have?	Qualitative single case study	<ul style="list-style-type: none"> <li>• Stakeholder involvement is influenced by the type of leadership and stakeholder involvement capability</li> <li>• Leadership is essential to enable wide, fair, and constructive stakeholder participation</li> <li>• Stakeholder involvement is encouraged by personal influences (good stakeholder relationships and positive mind-sets) and external influences (information quality and accessibility, context, and implementation priorities)</li> </ul>
<b>Watson et al., 2018</b>	Multiple internal and external stakeholders	Which capabilities does the development of environmental innovations require?	Systematic literature review	<ul style="list-style-type: none"> <li>• First order dynamic capabilities for stakeholder engagement management</li> <li>• Second order dynamic capabilities for systematized learning</li> <li>• Specific operational capabilities for marketing, environmental issues, and technologies that impact the effectiveness of dynamic capabilities</li> </ul>

Formal structures, including the assignment of clear responsibilities, tasks, and milestones, support stakeholder coordination by accounting for their heterogeneous goals, and facilitate the development of heterogeneous innovation alternatives in complex innovation projects (e.g., Dvir et al., 1998; Gann and Salter, 2000; Davies and Hobday, 2005, Timur and Getz, 2008; Widén et al., 2013). However, in respect of a high level of formalization, this may have the opposite effect regarding deep stakeholder involvement (Aggeri and Segrestin, 2007; Kavanagh and Naughton, 2009). Formal management methods can hamper the absorption of skeptical stakeholders' contributions, because the handling of heterogeneous and possibly inconsistent information is not possible when processes are too narrowly defined (e.g., Schultz et al., 2019a; Schultz et al., 2019b). The intensive involvement of skeptical stakeholders, particularly, requires the ability to get into touch with stakeholders in a spontaneous manner. This calls for high process flexibility. High formalization also decreases a project team's absorptive capacity, which in general is positively associated with performance (e.g., Lane and Lubatkin, 1998). Formal management may thus be a double-edged sword regarding skeptical stakeholder involvement: A too low degree of formal management hinders skeptical stakeholder coordination, while a too high degree of formal management hampers the flexibility of skeptical stakeholder involvement. Formal management can thus have an inverted u-shaped effect on skeptical stakeholder involvement.

*Hypothesis 3: Formal management has an inverted u-shaped effect on the intensity of skeptical stakeholder involvement.*

## **Methods**

### **Data collection and sample**

The hypotheses were investigated based on text analysis, text mining, online desk research, and survey data on a German, publicly funded, urban innovation initiative, similar to the French initiative *ÉcoQuartier* (Joss, 2015). The goal of these initiatives is to develop innovation alternatives that decrease a city district's carbon emissions and increase its energy efficiency. A project team, consisting of public and private organizations such as the public administration, energy providers, and housing companies, develops innovation alternatives for implementation in a specific urban environment and summarizes them in a written planning document. Hence, we focus on the front end of urban innovation. The

funding guidelines include, but are not limited to, an in-depth investigation of a city district's initial situation, the development of concrete alternatives, and the mobilization, information, and extensive consultation of stakeholders (Kreditanstalt für Wiederaufbau, 2019). We believe that only innovative alternatives can cope with the future ecological needs of cities. Nevertheless, only the implementation of innovation alternatives ensures urban development. The overall objective and context of the initiative are the same for all project teams. As a result, all projects can select innovation projects from the same portfolio of existing alternatives for urban sustainability. Therefore, we can compare the nature of the individual innovation projects within our sample.

To overcome single source bias, we measured the *innovativeness* and the *implementation orientation* of the urban innovation projects on the basis of the planning documents. The innovativeness (as the outcome of the analyzed written planning documents) was measured based on a text analysis of the composition of the innovation portfolio (e.g., Schultz et al., 2012; Antons et al., 2018). The degree of innovativeness of the written and published documents of the urban innovation projects was evaluated based on the concrete innovation alternatives that the respective project teams suggested for implementation. As a first step, we manually extracted the innovation alternatives from each of the 169 planning documents. Thereafter, as a second step, we clustered the list of innovation alternatives and summarized those that were similar. Some project teams suggested, for example, introducing bike sharing of electric bicycles. As there are two different types of motor engagement (pedal assist and throttle), we grouped both types of electric bicycles into a single cluster labeled electric bike sharing. This also accounts for similar innovation alternatives and synonyms. As a third step, we evaluated the innovativeness of the 90 innovation clusters obtained, based on their frequency in the sample (frequency of cluster in sample/sample size). A cluster has a high diffusion rate and thus a low innovation value if a large number of projects suggest the implementation of this cluster, and vice versa. The dependent variable degree of innovativeness relies on an inverted diffusion rate. Therefore, we inverted the diffusion rates of the clusters ( $1/\text{diffusion rate}$ ), and as a fourth and final step, to measure the project-specific degree of innovativeness, we calculated the mean of the inverted diffusion rates of all clusters contained in a planning document. This overall diffusion rate is then used as the degree of innovativeness in the following regression analysis. Table 3 presents examples of clusters in each of the four quartiles of the inverted diffusion rate.

**Table 3. Clusters, depending on their innovation field and inverted diffusion rate**

Innovation field	Degrees of innovativeness (as inverted diffusion rate)			
	High degrees of innovativeness (highest inverted diffusion rate)	High to medium degrees of innovativeness	Medium to low degrees of innovativeness	Low degrees of innovativeness (lowest inverted diffusion rate)
Energy efficient energy use	Smart home applications	(-)	(-)	Change in street lightning
Use of renewable energy	Geothermal energy use	Wind power installation	Photovoltaic solar panel installation	Solar thermal collector installation
Energetic house renovation	Roof greening	Use combined heat and power systems	Hydraulic calibration of heating systems	Change and extend house insulations
Climate-friendly mobility	Infrastructures for natural gas	Organize ride services for residents in a city district	Infrastructures for electric mobility	Strengthen public transportation
Optimization of heat supply	Seasonal thermal energy storages	Contracting	(-)	Extension of long-distance heating
Climate-friendly consumer behavior	Establishment of non-profit operating companies	Use synergies in a multigenerational house	Stakeholder education and training regarding behavior	Public relations

We analyzed the validity of the degree of innovativeness using survey data (see below), where the project team evaluated the innovativeness of their developed innovation alternatives. We used items based on the multidimensional innovation degree measurement used in the article of Schultz et al. (2013) to account for the different innovation dimensions of urban innovations (e.g., Nam and Pardo, 2011). The first construct (*organizational degree of innovativeness*) relies on five items that indicate the market newness of the innovation alternatives, the newness of the urban environment, and the impact of the innovation alternatives on the structures of the urban ecosystem, such as established communication channels. The second construct (*technological degree of innovativeness*) includes two items that show the technological newness of the urban innovation project and the extent to which the project content exceeds the funding guidelines. Both the organizational and the technological innovativeness are reported in Appendix 1. The urban innovation projects' innovativeness and the organizational degree of innovativeness correlate with a value of .16 ( $p=.11$ ), whereas the degree of innovativeness and the technological degree of innovativeness correlate with a value of .17 ( $p=.08$ ), both correlations supporting the content validity of our construct.

To show that the involvement of skeptical stakeholders has positive influences in addition to its positive influence on a project's innovativeness, we furthermore investigated

the influence of stakeholder involvement on the dependent variables *implementation orientation* and current *implementation status*. We follow the principle of sentiment analysis in opinion mining (e.g., Meyer et al., 2008; Pang and Lee, 2008) to assess the implementation orientation. As urban innovation projects have an implementation horizon longer than five years, and because each project team had a clear implementation focus during the innovation development phase, we assume that the more often words like ‘implementation’, ‘realization’, and ‘application’ are used in a planning document, the higher the measure of the implementation orientation. Evaluating the implementation orientation based on its wording corresponds with recent literature (e.g., Uotila et al., 2009), and is also reasonable as the project teams investigate the cities’ district structures in depth during the development phase. The planning document thus shows how intensively a project team considered the actual implementation and how they intend to encourage the implementation of their developed innovation alternatives. After reading a random sample of a third of the included 169 planning documents, it was assumed that innovation alternatives without an implementation purpose were not recorded in the planning documents. This is the reason why an analysis of word bigrams like ‘not implemented’ was excluded from the measure of the implementation orientation.

To assess the implementation orientation, the documents of the 169 urban innovation projects were decomposed into text blocks, containing only words that occurred more than once per planning document, resulting in a document-term-matrix with a sparsity of 94%. We excluded these words to increase the validity of our measure. Afterwards, we developed a wordlist containing 111 German words accounting for 15 word families that indicate a high willingness to implement the urban innovation alternatives, and assessed its content validity via two individual researchers who evaluated the wordlist independently from each other. Additionally, an expert who was a member of several urban innovation project teams evaluated the inclusiveness of the wordlist. The implementation orientation was then measured as follow: The number of words from the wordlist was counted in every decomposed planning document and divided by the total number of the planning document’s words. This weighted word count was then used to represent implementation orientation in the subsequent regression analysis.

The measurement the third dependent variable *implementation status* was based on extensive online desk research. We checked websites and newspaper articles related to all the sample’s projects and evaluated whether and which innovation alternatives were

implemented. Thereafter, we checked whether the implemented innovation alternatives were in the initial planning document, or whether the project team implemented alternatives they had not previously developed and planned for implementation. We disregarded the latter alternatives and only counted the alternatives, in the process of being implemented, included in the planning document. The implementation status measure was calculated as the proportion of implemented alternatives in relation to the number of alternatives in the planning document per urban innovation project. A second researcher validated the results.

The text-based document and online data were combined with the survey data of the project team. To overcome the likelihood of common method bias, all 169 project teams were invited to join the survey on stakeholder involvement and formal management during the urban innovation development. In total, 107 project teams of different urban innovation projects, including 136 organizations (1.27 participating organizations per urban innovation project), completed the survey. This study therefore draws on a high response rate of 64%. The variables, that were assessed by several project team organizations for a single urban innovation project, were aggregated to an urban-innovation-project score by calculating the mean values across their individual responses. Table 4 indicates the sample's characteristics, among others the regional ecosystem's size (represented by the cities' size) and the functional background of the survey respondents by organization.

## **Measures**

The data obtained from the planning documents and online desk research were combined with survey data, mainly based on established indicators used in prior research. The development of new scales closely followed the corresponding literature. The developed measures' content validity was assessed via a pretest involving practitioners from five organizations participating in urban innovation projects. Based on the received feedback, minor adaptations were made to the items' wording to remove remaining ambiguities. Reflective multi-item measures and five-point Likert-type scales were used for all multivariate constructs of the study, as reported in Appendix 1. The applied measures were tested for validity and reliability, and Cronbach's alpha coefficients were calculated and ranging at satisfactory levels between .71 and .86.

**Table 4. Sample characteristics**

<b>Size of the regional ecosystem (based on the city's size)</b>	<b>Number</b>	<b>Percent</b>	<b>Size of the urban innovation project (based on the city districts' inhabitants)</b>	<b>Number</b>	<b>Percent</b>
Rural community (<5,000 inhabitants)	10	9.4%	<1,000	35	32.7%
Small town (5,001-20,000 inhabitants)	30	28.0%	<2,500	28	26.2%
Medium-sized town (20,001-100,000 inhabitants)	40	37.4%	<5,000	20	18.7%
Large city (>101,001 inhabitants)	27	25.2%	≥5,000	24	22.4%

<b>Number of informants per urban innovation project</b>			<b>Size of the project team</b>	<b>Number</b>	<b>Percent</b>
1 informant	83	77.6%	2 team members	20	18.7%
2 informants	20	18.7%	3 team members	37	34.6%
3 informants	4	3.7%	4 team members	21	19.6%
			5 team members	11	10.3%
			6 team members	4	3.7%
			≥ 7 team members	13	12.2%
			not available	1	0.9%

n=107 urban innovation projects

<b>Type of participating organization</b>	<b>Number</b>	<b>Percent</b>
Architects/Engineers/Planners	65	47.8%
Community/City	16	11.8%
Construction company	1	0.7%
Energy agency	8	5.9%
Energy provider	12	8.8%
Housing company/Real estate company	4	2.9%
University/Research institute	12	8.8%
Others	18	13.2%

n=136 organizations

The internal consistency of the measured constructs is therefore acceptable as all values were above the threshold of .7 (Nunnally and Bernstein, 1978). Principal component analysis (promax rotation), separately conducted for each construct's items, only extracted one factor with eigenvalues greater than one, demonstrating these items' unidimensionality (see Appendix 1). Further, the variance inflation factors that test for potential multicollinearity were merely below the recommended threshold of 10 (Hair et al., 2009) for all predictors in all models. The highest variance inflation factor in the first regression analysis (influence of skeptical stakeholder involvement intensity on urban innovation success) is 1.48 (neutral stakeholder involvement intensity). The highest value of the variance inflation factor in the second regression analysis (capabilities for skeptical stakeholder involvement) is 2.09 (teamwork quality). The means, standard deviations, and correlations of the variables are reported in Table 5.

**Table 5. Mean, standard deviations, and correlation matrix**

Construct	Mean	S.D.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. District size	3,162	3,683	(-)													
2. Content breadth	18.15	9.99	.12	(-)												
3. Team size	2.39	1.23	.06	.07	(-)											
4. Project sustainability	3.63	.86	-.05	.14	-.07	(-)										
5. Stakeholder involvement experience	.95	.62	.02	.09	-.06	.01	(-)									
6. Neutral stakeholder involvement intensity	6.29	4.52	.04	.06	.03	.06	.10	(-)								
7. Supportive stakeholder involvement intensity	5.62	6.05	-.02	.06	.05	.06	.18	.40**	(-)							
8. Teamwork quality	4.04	.69	-.10	.02	-.05	.35**	-.12	.13	.23*	(-)						
9. Resource availability	4.09	.69	-.13	-.13	-.05	.22*	.04	.15	.25*	.38**	(-)					
10. Formal management	3.95	.90	-.06	.02	-.07	.25*	.07	.05	.28**	.58**	.27**	(-)				
11. Skeptical stakeholder involvement intensity	5.67	3.30	.02	.01	.07	.08	-.05	.48**	.26**	.23*	.29**	.13	(-)			
12. Innovativeness	6.33	2.51	-.10	.07	.19*	.07	.15	-.03	-.07	.01	-.13	.05	.11	(-)		
13. Implementation orientation	.03	.02	.33**	.03	-.16	.01	-.01	.10	.08	.14	.14	.17	.20*	-.07	(-)	
14. Implementation status	.21	.14	-.11	-.43**	-.16	-.05	-.05	-.19	-.23*	-.06	.12	-.18	-.16	-.13	.06	(-)

S.D., standard deviation.

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$  (two-tailed).

n=107 urban innovation projects



*Stakeholder involvement* was captured based on the collaboration intensity of the different stakeholder groups participating in the urban innovation development process. As a first step, the respondents could choose between 22 different stakeholders relevant to their urban innovation project. These stakeholders originate from a city's ecosystem (Kastalli and Neely, 2013) and include profit-oriented organizations (e.g., energy providers, real estate companies, service providers), residents (e.g., citizen groups, owners, tenants), academia (e.g., research institutes, universities), and non-profit organizations (e.g., the federal government and utilities). As a second step, the respondents were asked to evaluate the collaboration intensity with the relevant stakeholder groups during three different development phases (information generation, the development of innovation alternatives, and a decision on relevant innovation alternatives) on a five-point scale ranging from 'no collaboration' to 'very intensive collaboration' (Heravi et al., 2015). As a third step, the respondents were asked to rate the attitude of the chosen stakeholders toward the urban innovation project on a five-point Likert-type scale ranging from 'very skeptical' to 'very supporting', and the influence of these stakeholder groups on the implementation probability of the suggested innovation alternatives on a five-point Likert-type scale ranging from 'not influential' to 'very influential' (Mitchell et al., 1997; Freeman, 2010). The stakeholder groups that had no influence on the implementation probability were excluded. To assess the involvement of stakeholder groups based on their attitude, three stakeholder groups (negative, neutral, and positive attitude) were built, again using the five-point Likert-type scale. Subsequently, the collaboration intensity during the three phases was summed for each of these three stakeholder groups. This results in three variables, namely *skeptical stakeholder involvement intensity*, *neutral stakeholder involvement intensity*, and *supportive stakeholder involvement intensity*. The latter two variables serve as controls in the analysis to account for the potential tendency of project teams to collaborate with external stakeholders. A high average intensity indicates the higher importance of stakeholder involvement, while a low average intensity indicates the lower importance of stakeholder involvement. In general, skeptical stakeholder groups are those groups that have to invest in the implementation of the developed innovation alternatives (construction companies, medium and large-sized industries, private homeowners, real estate companies, service providers, small-sized industries, and tenants). This study thus provides a new, fine-grained measurement of stakeholder involvement intensity depending on stakeholder attitude. It accounts for the blurred boundaries between supportive and skeptical stakeholders, independently of their role in an innovation system

(e.g., Post et al., 2002), and additionally assesses the involvement intensity during the three phases of the front end of innovation.

*Teamwork quality* was assessed based on seven items drawn from previous literature (Hoegl and Gemuenden, 2001). The respondents were asked to rate whether the workload was distributed fairly between all team members, and whether all work packages and goals were coordinated and communicated. Further items were included on communication and conflict-solving in the team and on the overall goals of the team members.

*Formal management* was captured by using five items drawn from previous literature (Kleinschmidt et al., 2007; Teller et al., 2012). The respondents evaluated their project management and rated whether they had defined project phases in terms of milestones, clear responsibilities, project goals, and time and budget plans.

*Resource availability* was assessed in terms of four items indicating whether the project team was equipped with enough resources (Belassi and Tukel, 1996; Bergek et al., 2008). Therefore, the respondents evaluated whether they had the required personnel, professional knowledge, IT and planning tools, and financial resources to develop the innovation alternatives.

Five additional covariates were included to ensure the models' robustness. *District size* was included as a continuous variable. To account for differences between smaller and larger urban areas, it relied on the number of inhabitants directly influenced by the urban innovation project. The number of inhabitants were based on the information provided by the urban innovation projects' planning documents. To control for the *content breadth* of the urban innovation project, the number of developed innovation alternatives were identified in respect of each planning document, ranging from one to 57 developed innovation alternatives per urban innovation project. Thereby, we control for the extent of the urban innovation projects and ensure that the dependent variables are not influenced by the number of developed innovation alternatives. The *team size* is equal to the number of different organizations listed as responsible in the planning document. Thus, we control for the influence of diverse professional knowledge on the dependent variables. Previous research suggested that for example, knowledge diversity affects the innovativeness (e.g., Talke et al., 2011). Between two and seven organizations were involved as members of the innovation project.

*Project sustainability* refers to the future impact of the urban innovation project on and its sustainability in the urban space, to control for the relevance of the project on sustainable urban development and to ensure that the project meets its purpose. This covariate was assessed by using three items (e.g., Gibson, 2006). The respondents rated whether their innovation alternatives contribute to the ecological, economic, and social sustainability of the urban district. Like stakeholder involvement intensity and to assess *stakeholder involvement experience*, the respondents were asked to rate how intensively they collaborated with their urban innovation project's relevant stakeholder groups before the implementation of the urban innovation project. Therefore, before the urban innovation project started, they evaluated the collaboration intensity on a five-point scale ranging from 'no collaboration' to 'very intensive collaboration'. The average intensity of all relevant stakeholder groups was included in the study's model. We control for the stakeholder involvement experience, because the stakeholder involvement experience could influence the stakeholder involvement intensity in the urban innovation projects, and thereby influence the project outcomes. In this context, previous research confirms that experience positively influences the innovativeness (e.g., Yuan et al., 2014; Vaillant et al., 2019). Thus, we ensure that the outcomes of the urban innovation projects are not influenced by stakeholder involvement experience.

## **Results**

To test the hypotheses, we developed four models and calculated them using linear regression. The first regression tests the influence of stakeholder groups, dependent on their attitude, on the urban innovations' innovativeness (Model 1, Table 6), implementation orientation (Model 2, Table 6), and implementation status (Model 3, table 6). The second regression accounts for the capabilities that facilitate skeptical stakeholder involvement (Model 4, Table 7).

The first regression analysis includes Model 1, Model 2, and Model 3 (Table 6). Model 1a is the baseline model with the dependent variable degree of innovativeness, while Model 1b adds the independent variable skeptical stakeholder involvement intensity to investigate the linear effects. Model 2a is the baseline model with the dependent variable implementation orientation and Model 2b also adds the skeptical stakeholder involvement intensity. Model 3a is the baseline model with the dependent variable implementation

status and Model 3b adds the independent variable. We focus on the results of the models with the highest level of fit, Model 1b ( $R^2=.13$ ;  $F=1.74$ ), Model 2b ( $R^2=.18$ ;  $F=2.70$ ), and Model 3b ( $R^2=.26$ ;  $F=4.18$ ).

In Model 1b, two of the seven covariates have a significant influence on the degree of innovativeness. The team size, representing diverse professional knowledge, positively influence the degree of innovativeness ( $\beta=.21$ ;  $t=2.15$ ;  $p=.03$ ). The Stakeholder involvement experience of the project team has a positive and significant influence on the degree of innovativeness ( $\beta=.20$ ;  $t=2.09$ ;  $p=.04$ ). In Model 2b, two covariates significantly influence the implementation orientation. The larger the district size the higher the implementation orientation of the urban innovation project ( $\beta=.34$ ;  $t=3.63$ ;  $p=.00$ ). The team size has a negative and significant influence on the implementation orientation ( $\beta=-.20$ ;  $t=-2.11$ ;  $p=.04$ ). In Model 3b, the covariates control breadth and supportive stakeholder involvement intensity have a significant influence on the implementation status. Both the content breadth ( $\beta=-.40$ ;  $t=-4.50$ ;  $p=.00$ ) and the supportive stakeholder involvement intensity ( $\beta=-.17$ ;  $t=1.74$ ;  $p=.09$ ) negatively influence the implementation status. Thus, urban innovation projects that have a broad portfolio and those that intensively involve supportive stakeholders, attain lower levels of implementation.

The regression analysis of Model 1 refers to the relationship between skeptical stakeholder involvement intensity and the innovativeness and reveals a positive and significant influence of their involvement intensity on the degree of innovativeness ( $\beta=.19$ ;  $t=1.71$ ;  $p=.09$ ), thereby supporting hypothesis 1a. The regression analysis of Model 2 shows a significant and positive influence of skeptical stakeholder involvement intensity on the implementation orientation, thereby supporting hypothesis 1b ( $\beta=.20$ ;  $t=1.87$ ;  $p=.06$ ). The regression analysis of Model 3 shows no significant influence of skeptical stakeholder involvement intensity on the implementation status, thereby not supporting hypothesis 1c. The effect sizes of the models, including all direct and moderating effects, is medium (Model 1:  $f^2=.15$ ; Model 2:  $f^2=.22$ ; Model 3:  $f^2=.35$ ; Cohen, 1988).

**Table 6. Regression results of stakeholder involvement intensity on innovativeness, implementation orientation, and implementation status**

	<i>Dependent variable innovativeness</i>			<i>Dependent variable innovativeness</i>			<i>Dependent variable implementation orientation</i>			<i>Dependent variable implementation orientation</i>			<i>Dependent variable implementation status</i>			<i>Dependent variable implementation status</i>		
	Model 1a			Model 1b			Model 2a			Model 2b			Model 3a			Model 3b		
	$\beta$	p	t	$\beta$	p	t	$\beta$	p	t	$\beta$	p	t	$\beta$	p	t	$\beta$	p	t
<i>Controls</i>																		
District size	-.12	.22	-1.24	-.12	.21	-1.27	<b>.34</b>	<b>.00</b>	<b>3.60</b>	<b>.34</b>	<b>.00</b>	<b>3.63</b>	-.05	.57	-.57	-.05	.57	-.57
Content breadth	.05	.65	.46	.05	.61	.52	-.00	.98	-.03	.00	.98	.03	<b>-.40</b>	<b>.00</b>	<b>-4.49</b>	<b>-.40</b>	<b>.00</b>	<b>-4.50</b>
Team size	<b>.22</b>	<b>.03</b>	<b>2.24</b>	<b>.21</b>	<b>.03</b>	<b>2.15</b>	<b>-.19</b>	<b>.05</b>	<b>-1.97</b>	<b>-.20</b>	<b>.04</b>	<b>-2.11</b>	-.11	.20	-1.29	-.11	.22	-1.24
Project sustainability	.08	.42	.81	.07	.48	.72	.00	.97	.04	-.01	.95	-.07	.01	.93	.09	.01	.89	.14
Stakeholder involvement experience	<b>.18</b>	<b>.06</b>	<b>1.88</b>	<b>.20</b>	<b>.04</b>	<b>2.09</b>	-.05	.64	-.47	-.024	.80	-.2572	.02	.84	.21	.01	.91	.114
Neutral stakeholder involvement intensity	-.02	.89	-.14	-.10	.39	-.87	.07	.47	.73	-.02	.88	-.15	-.09	.37	-.91	-.05	.62	-.50
Supportive stakeholder involvement intensity	-.12	.28	-1.10	-.13	.21	-1.26	.07	.49	.69	.05	.60	.53	<b>-.18</b>	<b>.07</b>	<b>-1.82</b>	<b>-.17</b>	<b>.09</b>	<b>-1.74</b>
<i>Predictor</i>																		
Skeptical stakeholder involvement intensity				<b>.19</b>	<b>.09</b>	<b>1.71</b>				<b>.20</b>	<b>.06</b>	<b>1.87</b>				-.08	.46	-.74
<b>R<sup>2</sup></b>	<b>.10</b>			<b>.13</b>			<b>.15</b>			<b>.18</b>			<b>.25</b>			<b>.26</b>		
<b>Adjusted R<sup>2</sup></b>	<b>.03</b>			<b>.05</b>			<b>.09</b>			<b>.11</b>			<b>.20</b>			<b>.19</b>		
<b><math>\Delta R^2</math></b>				<b>.03</b>						<b>.02</b>						<b>.01</b>		
<b>f<sup>2</sup></b>	<b>.11</b>			<b>.15</b>			<b>.18</b>			<b>.22</b>			<b>.33</b>			<b>.35</b>		
<b>F</b>	<b>1.54</b>			<b>1.74</b>			<b>2.54</b>			<b>2.71</b>			<b>4.72</b>			<b>4.18</b>		
<b><math>\Delta F</math></b>				<b>.20</b>						<b>.17</b>						<b>.54</b>		

Dependent variable in Model 1 is innovativeness; dependent variable in Model 2 is implementation orientation; dependent variable in Model 3 is implementation status; n=107; the table contains standardized coefficients with p and t-values (two-tailed)

The second regression analysis tests the relationship between resource availability, teamwork quality, and formal management on skeptical stakeholder involvement (Table 7). Model 4a is the baseline model and Model 4b adds all independent variables to investigate the hypotheses. We focus on the results of the model with the highest level of fit, Model 4b ( $R^2=.18$ ;  $F=2.19$ ). The sample size of the second regression analysis is reduced to 99, because eight projects did not have any skeptical stakeholders and thus no skeptical stakeholder involvement intensity. The results show that resource availability has a positive and significant effect ( $\beta=.29$ ;  $t=2.65$ ;  $p=0.01$ ) on the skeptical stakeholder involvement intensity, thereby supporting hypothesis 2a. However, the teamwork quality does not influence skeptical stakeholder involvement, thereby not supporting hypothesis 2b. Formal management has a positive and linear, but inverted u-shape influence on the skeptical stakeholder involvement intensity (linear effect  $\beta=1.87$ ;  $t=2.56$ ;  $p=0.01$ ; quadratic effect  $\beta=-1.78$ ;  $t=-2.53$ ;  $p=0.01$ ). Hypothesis 3 is thus supported. The effect size of the model, including all direct and moderating effects, is medium ( $f^2=.22$ ; Cohen, 1988). Figure 1 depicts the overall model and path coefficients.

**Table 7. Regression results for capabilities of skeptical stakeholder involvement**

	Model 4a			Model 4b		
	$\beta$	p	t	$\beta$	p	t
<i>Controls</i>						
District size	.04	.73	.35	.04	.67	.43
Content breadth	-.04	.72	-.36	-.08	.48	-.72
Team size	.02	.89	.14	.03	.76	.31
Project sustainability	.06	.58	.56	-.05	.66	-.45
Stakeholder involvement experience	<b>.18</b>	<b>.08</b>	<b>1.75</b>	<b>.17</b>	<b>.08</b>	<b>1.75</b>
<i>Predictors</i>						
Teamwork quality				-.05	.72	-.35
Resource availability				<b>.29</b>	<b>.01</b>	<b>2.65</b>
Formal management				<b>1.87</b>	<b>.01</b>	<b>2.56</b>
Formal management <sup>2</sup>				<b>-1.78</b>	<b>.01</b>	<b>-2.53</b>
<hr/>						
<b>R<sup>2</sup></b>		<b>.04</b>			<b>.18</b>	
<b>Adjusted R<sup>2</sup></b>		<b>-.02</b>			<b>.10</b>	
<b><math>\Delta R^2</math></b>					<b>.15</b>	
<b>f<sup>2</sup></b>		<b>.04</b>			<b>.22</b>	
<b>F</b>		<b>.70</b>			<b>2.19</b>	
<b><math>\Delta F</math></b>					<b>3.94</b>	

Dependent variable is skeptical stakeholder involvement intensity; n=99; table contains standardized coefficients with p and t-values (two-tailed)

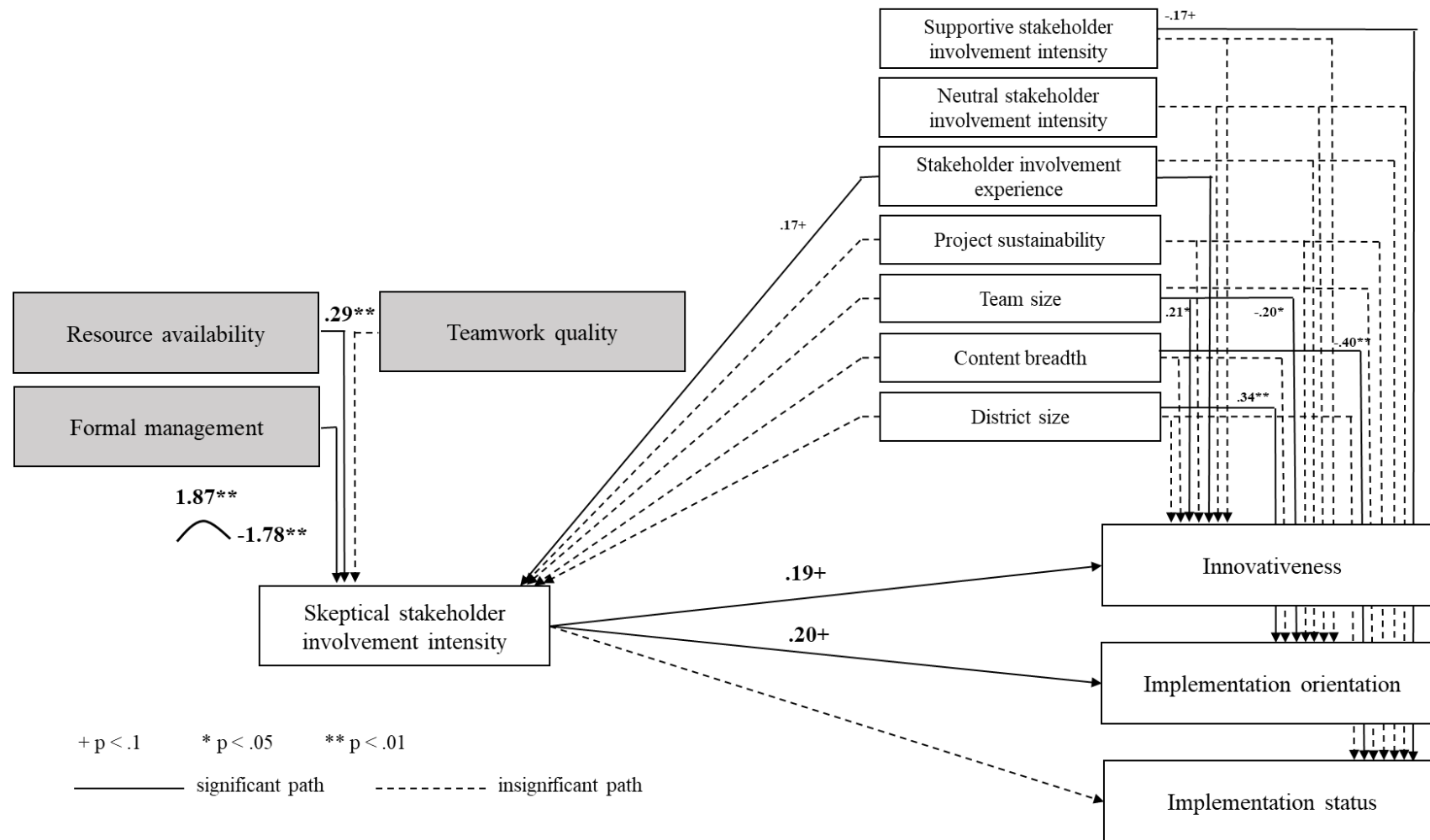


Figure 1. Overview on models and path coefficients of all regression analyses

## Discussion

High innovativeness is desirable in urban innovation projects to achieve the sustainable transition of established urban structures. The results show that most of the projects have a low innovativeness and only a few manage to develop radical innovative urban planning documents. Nevertheless, this study's results emphasize the importance of two innovation dimensions, which is in line with previous innovation management literature (e.g., Schultz et al., 2013): technological degree of innovativeness and organizational degree of innovativeness in the sense of the innovative organization of a district's development (see Table 3). The combination of these two dimensions results in unique district solutions. Against the background of a district's heterogeneity, district-specific solutions with an appropriate level of innovativeness seem most promising. Since an urban innovation initiative cannot influence the regulatory conditions, this innovation dimension may be omitted. This study shows that the involvement of skeptical stakeholders, such as tenants and construction companies that are common to the urban ecosystem, provides a way to achieve project success. Temporary organizations, like urban innovation projects, thus profit from the heterogeneity of the participants' attitudes and especially from those of the skeptical participants.

According to the first regression analysis, skeptical stakeholders constitute the only stakeholder group that significantly and positively influences urban restructurings' innovativeness. The literature also states that so-called champions, that is stakeholders who fully support an innovation, encourage the innovation development process (e.g., Hauschildt, 1999; Markham, 2000; Walter et al., 2011) and support the innovation adoption and implementation (e.g., Howell et al., 2001). Our results do not support this assumption, because supportive stakeholders can have a negative effect on the implementation status of urban innovation projects. Although these stakeholder groups do not question the innovation alternatives as much as skeptical stakeholders do, too close collaboration may result in implementation delays (e.g., Jones et al., 2018). This is conceivable, because too close stakeholder involvement in general can lead to escalating stakeholder expectations and stakeholder disappointment when their input is not realized (Greenwood, 2007). Stakeholders who neither oppose nor support complex innovation projects are not committed and thus show little interest. Although addressed by the purpose of a temporary organization, they will not participate actively in the innovation development process unless they change their position from neutral to skeptical or supportive. Our results show



that the innovativeness and implementation of urban innovations does not benefit from involvement of neutral stakeholders.

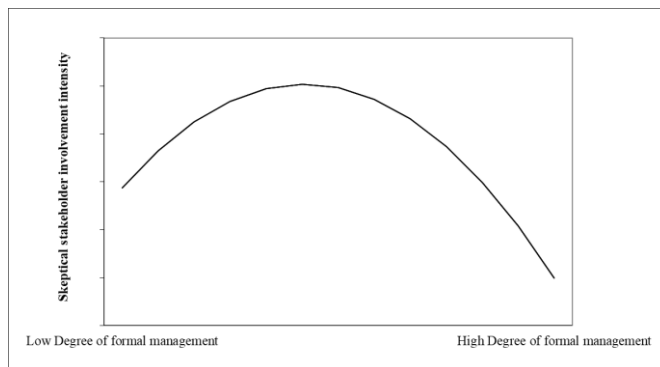
Nevertheless, our results support the concept of loyal opposition, based on the innovation management literature, and underline the value of skeptical stakeholders' contribution to innovativeness and implementation orientation (Hauschildt, 1999; Markham, 2000). Collaboration with skeptical stakeholders on a project increases the knowledge base and provides a mean to reduce perceived barriers. This is a justified conclusion as current research also confirms that stakeholder engagement increases the development of shared goals and motivation (Ruehli et al., 2017; Juntunen et al., 2019). Our results further underline this effect, considering that early skeptical stakeholder involvement increases the innovation implementation orientation in the innovation development. Skeptical stakeholder involvement emphasizes innovation development that goes beyond existing standards and ensures at the same time that the project team does not lose the implementation focus. The significance levels of the regression results ( $p < .1$ ) thereby contribute to the discussion on whether skeptical stakeholder involvement is positive or not. Although stronger effect sizes would indicate stronger positive influences, the results show that the benefits of skeptical stakeholders are larger than their drawbacks. However, the results do not support that skeptical stakeholder involvement results in higher levels of current implementation. This might indicate a conflict between the implementation orientation and the implementation status (supported by the low correlation coefficient of both variables in Table 5). Other factors like regulatory conditions might hamper urban innovation implementation. Further, it is conceivable that the implementation is not completed and therefore, the influence of skeptical stakeholder involvement is not yet measurable because of this long time horizon of urban innovation implementation.

Furthermore, the results show reverse influences of the covariate team size (i.e. the diverse professional knowledge) on urban innovation success: while knowledge diversity increases the degree of innovativeness, it has the opposite effect on the implementation orientation. A large and diverse knowledge base might develop innovative solutions, but its heterogeneity might decrease the feasibility and result in losses of the implementation focus. This is in line with the result that skeptical stakeholders have no influence on the implementation status. Too deep involvement of one stakeholder group and too broad involvement of a diverse set of actors may lead to restricted information access and

knowledge exchange (Desai, 2018). Consequently, these close relationships result in high costs without necessarily generating greater implementation (Jones et al., 2018).

The results of the second regression analysis show that skeptical stakeholder involvement is mainly driven by high resource availability and a moderate degree of formal management that structures the involvement process. In contrast to what recent project management literature suggests (e.g., Haas, 2006), teamwork quality does not influence skeptical stakeholder involvement. In temporary organizations, skeptical stakeholder involvement capability mainly depends on information and resource accessibility (Waligo et al., 2014; Pera et al., 2016), as well as on moderate levels of coordination inside and outside the organization (Schultz et al., 2019a). Knowledge transfer capabilities (Driessen and Hillebrand, 2013) and knowledge processing appear to be of less importance. This is understandable because temporary organizations are the organizational analog of a ‘one-night stand’ (Meyerson et al., 1996). In addition, the success of temporary organizations depends even more on prior knowledge, for example on stakeholder structures and behavior. However, the experience of stakeholder involvement can have a positive effect on skeptical stakeholder involvement intensity ( $\beta=.17$ ;  $t=1.75$ ;  $p=.08$ ). Previous studies (e.g., Karlsen, 2002) confirm this relationship; familiarity with stakeholders’ expectations and behavior eases future collaboration.

The relationship between formal management and skeptical stakeholder involvement shows decreasing marginal returns (see Figure 2) and thus combines the research findings confirming that formal management eases stakeholder involvement (e.g., Timur and Getz, 2008), and that formal management hampers stakeholder involvement in innovation projects (e.g., Kavanagh and Naughton, 2009; Schultz et al., 2019b). The regression results indicate that formal management’s positive influence on skeptical stakeholder involvement becomes weaker with higher degrees of formal management (linear effect  $\beta=1.87$ ;  $t=2.56$ ;  $p=.01$ ; quadratic effect  $\beta=-1.78$ ;  $t=-2.53$ ;  $p=.01$ ).

**Figure 2. Formal management's influence on skeptical stakeholder involvement**

## Implications and limitations

### Theoretical Implications

We transferred the concept of stakeholders' attitude from project management literature to instrumental stakeholder theory and show that distinguishing stakeholder involvement based on their position toward the project goals is a mean to attain high innovativeness and increase the implementation orientation in complex innovation projects. Thereby, we extended research on temporary organizations (Hadida et al., 2019) by identifying the mechanisms that underlie and encourage the success of these organizations. While stakeholders' legitimacy and urgency are the main criteria of stakeholder analysis in stakeholder theory (e.g., Mitchell et al., 1997), they should not be the only criterion of stakeholder involvement. Our results thus contribute to the call for additional stakeholder characteristics (e.g., Fliaster and Kolloch, 2017) and contribute to research that suggests that stakeholder focus is a prerequisite of success (e.g., Dobusch et al., 2019).

Against the backdrop of the increasing theoretical relevance of sustainable and innovative urban restructuring in innovation management literature, this study extends current knowledge on the underlying mechanisms in complex and systemic innovations for urban restructuring. We indicated that skeptical stakeholders are not only a cause of innovation resistance, but also a valuable source of knowledge and information for innovation development and implementation in the urban ecosystem, thereby extending research on innovation champions and antagonists (Markham, 2000). Innovation projects, particularly with the aim of transforming the urban space into smart cities, face substantial public opposition (e.g., Daskalaki and Kokkinidis, 2017; Di Maddaloni and Davies, 2017).

The positive effects confirmed by this research legitimize the scope of these projects, especially by providing empirical proof that skeptical stakeholder involvement increases urban transition instead of obstructing it.

Furthermore, this article extends current research by providing two optimized variable measurements. First, the study introduces an innovativeness measurement using an analysis of the composition of the innovation portfolio based on project documents. It is thus independent of the subjective evaluation of a project's innovativeness by, for example, the project team. Second, the study presents a more fine-grained measurement of stakeholder involvement intensity that accounts for it during the three phases of the front end of innovation, depending on the stakeholders' position on the project and their influence on the project implementation. Additionally, this article contributes to a deeper understanding of urban innovation as an innovation type, alongside well-known innovation types like product and service innovations.

### **Managerial Implications**

This research supports the managers of temporary organizations involved in urban innovation projects, to select relevant stakeholder groups to achieve high innovativeness and ensure the implementation orientation of the projects. Urban innovation project managers should distinguish between different stakeholder groups based on the groups' position on the project. As suggested by this study's results, collaboration with skeptical stakeholders may result in high innovativeness and higher implementation orientation. As most of this study's skeptical stakeholders have a private or for-profit background (construction companies, medium and large-sized industries, private homeowners, real estate companies, service providers, small-sized industries, and tenants), managers should pay particular attention to involving stakeholders who dread large financial investments and who closely scrutinize the project's profitability.

Furthermore, managers should especially distinguish the involvement intensity dependent on the desired outcome. Moderate involvement of skeptical stakeholders seems most promising regarding the quality and implementation of ideas. This conclusion contrasts with that of Grimpe et al. (2019) who suggest that skeptical stakeholders should be tightly bound to the organization. In a temporary setting, this may not be recommendable.

Managers of temporary organizations can develop a skeptical stakeholder involvement capability based on a rich resource base (enough knowledge and planning instruments), which has further a positive effect on the innovativeness, and by providing a moderate level of formal management. Enough personnel with diverse functional backgrounds should account for all the needs of the skeptical stakeholders. Stakeholder involvement experience may ease the involvement of highly skeptical stakeholders. Additionally, managers should develop formal management structures, but simultaneously ensure that formal management is not exercised too rigidly, as a high degree of formal management may hamper flexible stakeholder involvement.

### **Limitations and future research**

Despite its contributions, this study has certain limitations that must be considered. The study's measures do not account for dynamic changes in the attitude of stakeholders, because the project team only had a single opportunity to respond to the survey. It is conceivable that stakeholders change their position on the project as it progresses. Thus, future research could investigate how stakeholder groups change their attitude over time.

Although the model contains seven covariates, further covariates are necessary to explain more of the predicted variables' variances. Additionally, stakeholder involvement may not be the only predictor of urban innovations' innovativeness and implementation. It is, for example, possible that the functional background and the ambitions of the project team influence the innovativeness of the urban innovation project, although the control variable team size partly accounts for this relationship. Additionally, the study's sample size includes only German urban innovation projects. Future research could extend the sample size and include urban innovation projects developed and implemented outside Germany.

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## Appendix 1. Measures and corresponding factor loadings

Construct	Items	Factor loading
<b>Formal management</b>	( $\alpha=.815$ ) (1=strongly disagree, 5=strongly agree)	
	We had a formal process with e.g., clear project phases during the creation of the urban innovation planning document.	.894
	We had clearly defined roles and responsibilities.	.849
	We had goals and key figures to evaluate innovation alternatives and were thus able to control the inclusion of innovation alternatives in the urban innovation planning document.	.543
	We have defined milestones for individual work packages.	.740
<b>Resource availability</b>	( $\alpha=.714$ ) (1=strongly disagree, 5=strongly agree)	
	We had sufficient personal available to create the urban innovation planning document.	.782
	We had personal with all required professional backgrounds to account for all district-specific questions.	.738
	We had enough financial resources to create the urban innovation planning document.	.627
	We had access to required IT and planning instruments.	.786
<b>Teamwork quality</b>	( $\alpha=.877$ ) (1=strongly disagree, 5=strongly agree)	
	Every project team member had clear tasks and goals.	.714
	The tasks and goals of the project team members were generally coordinated and well-matched.	.788
	All project team members supported each other.	.803
	We have solved emerging conflicts quickly and purposefully.	.800
	We quickly agreed on solutions for important issues in the project team.	.800
	Every project team member made a significant contribution to the planning document and was anxious to complete the urban innovation project as quickly as possible.	.733
	It was a matter close to the project team's heart to promote the urban innovation project.	.649
<b>Sustainability of the developed innovation alternatives</b>	( $\alpha=.844$ ) (1=strongly disagree, 5=strongly agree)	
	Our developed innovation alternatives make a decisive contribution to the economical sustainability of the urban ecosystem.	.881
	Our developed innovation alternatives make a decisive contribution to the ecological sustainability of the urban ecosystem.	.864
	Our developed innovation alternatives make a decisive contribution to the social sustainability of the urban ecosystem.	.874
<b>Organizational degree of innovativeness</b>	( $\alpha=.765$ ) (1=strongly disagree, 5=strongly agree)	
	We established a new "we-feeling" with our urban innovation project in the city district.	.732
	We reached heterogeneous stakeholder groups like residents, small and medium-sized firms, the by developing urban innovation alternatives.	.690
	We established new ways of communication in the city district that will be used in future.	.835
	We as an organization built up contact to other organizations that we will use after the urban innovation project.	.744
	Our organization built up new knowledge that will change our processes and standards internally because of the urban innovation project.	.522
<b>Technological degree of innovativeness</b>	( $\alpha=.624$ ) (1=strongly disagree, 5=strongly agree)	
	The content of our urban innovation project exceeds the funding guidelines substantially.	.840
	We developed technologically new products and system innovations in our urban innovation project.	.814

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## 9 Appendix

### **Article I: Innovationskompetenz von Energieversorgern noch auf geringem Niveau**

Julia Kroh; Heiner Luetjen; Carsten Schultz

*Die wachsende Wechselbereitschaft der Kunden, die Digitalisierung und die Relevanz erneuerbarer Energien konfrontieren Energieversorger mit gravierenden Veränderungen. Das Wissen um die Weiterentwicklung und Implementierung von Prozess-, Produkt- und Dienstleistungsinnovationen wird zum zentralen Erfolgsfaktor. Die Ergebnisse der internationalen Innovationsmanagement-Studie „innovate! new“ der Christian-Albrechts-Universität zu Kiel zeigen, dass viele Energieversorger erst am Anfang der Entwicklung einer eigenen Innovationsfähigkeit stehen.*

Neben der Energiewende stellt die Digitalisierung einen weiteren Paradigmenwechsel für die Energiewirtschaft dar. Energieversorger als Lieferanten der klassischen Produkte Strom, Wasser und Wärme wandeln sich zu innovativen Dienstleistern von branchenübergreifenden Lösungsansätzen wie Elektromobilität oder Smart Home.

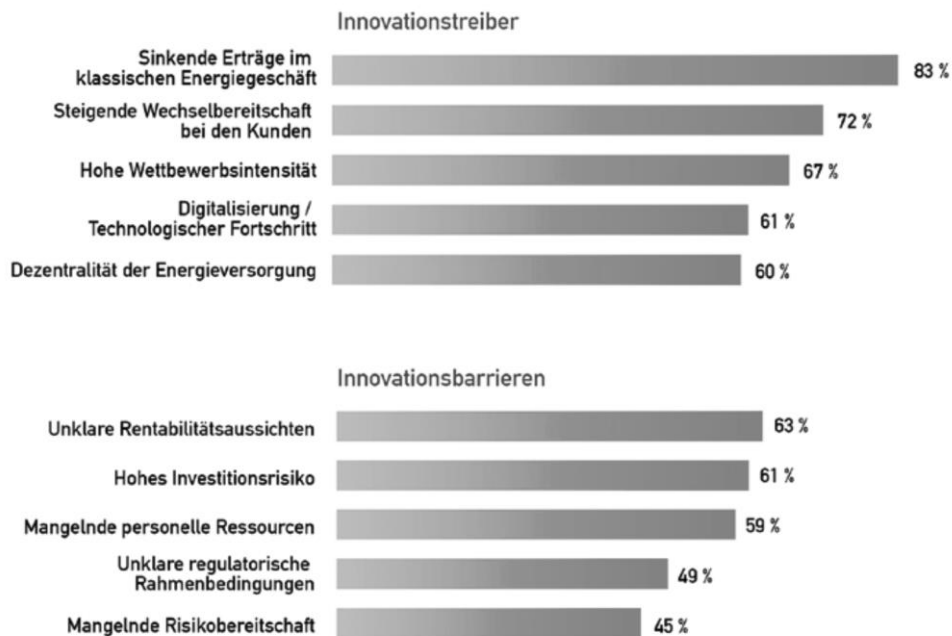
Aktuell sind Energieversorger im Durchschnitt in 21 Innovationsprojekten aktiv. Dezentrale Stromerzeugung, Energieberatung und neue Finanzierungsmodelle sind thematischer Fokus, jeweils 74% der teilnehmenden Energieversorger sind in diesen Bereichen innovativ tätig. Viele dieser Innovationsaktivitäten sind allerdings für Energieversorger bisher wenig bedeutend. So ist beispielsweise der Ausbau der dezentralen Stromerzeugung nur für 40% der teilnehmenden Energieversorger wirtschaftlich relevant.

Die Einführung intelligenter Messsysteme und der Ausbau von Smart Grids als Beispiel der Digitalisierung bisher analoger Netze wird von weniger als der Hälfte der teilnehmenden Energieversorger angegangen und lediglich von 30% als wirtschaftlich bedeutend angesehen. Die Ladeinfrastruktur für Elektromobilität wird von knapp 80% der Energieversorger umgesetzt, dagegen sehen weniger als 10% diese als wirtschaftlich bedeutend an. Bisher begrenzt sich der Großteil der Innovationsaktivitäten auf das klassische Kerngeschäft, wohingegen radikale Ansätze im Portfolio unterrepräsentiert sind.

#### **Innovationstreiber und Barrieren**

Stadtwerke und Energieversorger sehen sich wegen ihrer besonderen regulatorischen Voraussetzungen und ihrer oft kommunalen Trägerschaft mit anderen

Innovationsherausforderungen konfrontiert als Unternehmen anderer Branchen (Abbildung 1). Unterschiedlichste Herausforderungen entlang der Wertschöpfungskette führen dazu, dass nur 30% der teilnehmenden Energieversorger einen bisher nicht dagewesenen Kundennutzen mit ihren neuen Produkten/ Dienstleistungen generieren.



**Abbildung 1. Die fünf wichtigsten Innovationstreiber und Innovationsbarrieren**

Dabei erweisen sich vor allem unklare Rentabilitätsaussichten (63% der teilnehmenden Energieversorger) in Kombination mit einem hohen Investitionsrisiko (61% der Energieversorger) und fehlendem Personal (59% der Energieversorger) als innovationshinderlich. Die unklaren regulatorischen Rahmenbedingungen in der Energiewirtschaft sind für 49% der Energieversorger innovationsfeindlich. Zudem stellen 45% der teilnehmenden Energieversorger eine mangelnde Risikobereitschaft in der Energiewirtschaft fest.

Dagegen steigern bei 83% der teilnehmenden Energieversorger sinkende Erträge im klassischen Energiegeschäft den Drang zu innovieren. Die wachsende Wechselbereitschaft der Kunden wird von 72% der Energieversorger als innovationsfördernd angesehen. Den intensiven Wettbewerb nutzen 67% der Energieversorger als Innovationsanreiz. Die digitale Transformation und die zunehmende Umstellung in der Energieerzeugung auf dezentrale Technologien werden von teilnehmenden Energieversorgern als weniger

dringend empfunden: Nur knapp 60% der Energieversorger nutzen diese technologischen Veränderungen zur Entwicklung neuer Produkte und Dienstleistungen.

#### *Über die Studie*

innovate! new ist eines der umfassendsten Innovationsbenchmarks weltweit und unterstützt die teilnehmenden Unternehmen, auf neue Entwicklungen im Innovationsmanagement vorbereitet zu sein, um die eigene Innovationsleistung weiter zu steigern – mit dem Ziel, zu den Innovation Leaders zu gehören. Ein Team von Wissenschaftlern aus drei Ländern (Prof. Dr. Sören Salomo, Technical University of Denmark; Prof. Dr. Erich Schwarz, Alpen-Adria-Universität; Prof. Dr. Carsten Schultz; Christian-Albrechts-Universität zu Kiel; Dr. Dietfried Globocnik, Karl-Franzens Universität Graz; Prof. Dr. Rita Faullant, University of Southern Denmark) hat gemeinsam mit 20 Unternehmen die nächste Generation des Benchmarking innovate! austria, bei dem mehr als 190 Unternehmen aus 21 Branchen teilnahmen, entwickelt. Das Projekt innovate! new wurde unterstützt vom Bundesministerium für Wissenschaft, Forschung und Wirtschaft, dem Land Niederösterreich, der Industriellenvereinigung Niederösterreich und der Steirischen Wirtschaftsförderung.

Die Studie kann hier heruntergeladen werden: [www.techman.uni-kiel.de/de/innovate](http://www.techman.uni-kiel.de/de/innovate)

Weitere Informationen zu innovate! new erhalten Sie unter: <http://www.pfi.or.at/innovate-new>

### **Erfassung der Innovationsleitung**

Im Rahmen der gemeinsam mit der Plattform für Innovationsmanagement (PFI/ siehe Textkasten „Über die Studie“) im Jahr 2016 durchgeführten Innovationsmanagement-Studie „innovate! new“ wurde das Innovationsmanagementsystem von 74 größtenteils mittelständischen Unternehmen (u. a. Maschinenbauern, Software-Unternehmen oder Dienstleistern) und 46 Energieversorgern, von denen vier ihren Unternehmenssitz in Österreich haben, erhoben (siehe Textkasten „Befragungsbasis“). Das betriebliche Innovationsmanagementsystem wurde basierend auf dem Innovation Excellence Model (Abbildung 2) und seinen drei Kernelementen Innovationsleistung, Innovationsführung und -organisation sowie Innovationsprozess abgebildet.

Die Innovationsleistung im Zentrum des Modells wird über den Beitrag von Innovationen zum Unternehmenserfolg gemessen. Sie ist die Ergebnisgröße eines strukturierten Innovationsprozesses und innovationsfördernder Rahmenbedingungen.



**Abbildung 2. Innovation Excellence Model (Quelle: Plattform für Innovationsmanagement und Sören Salomo, 2007/2015)**

Die Innovationsführung und –organisation beschreibt die Ausprägung der Unternehmens- und Innovationsstrategie sowie die kulturellen und organisatorischen Rahmenbedingungen für innovative Aktivitäten. Der Innovationsprozess gliedert sich in drei idealtypische Phasen: Die Initiierung, die Entwicklung und die Markteinführung. Die Initiierung umfasst alle Tätigkeiten zur Ideenfindung und –abgrenzung: Die Definition des Marktes, die Erhebung der Kundenbedürfnisse und die technologische Früherkennung. In der Entwicklungsphase werden detaillierte Konzepte und Prototypen von Produkten, Dienstleistungen und Prozessen modelliert, die in der Markteinführung dem Kunden über unterschiedliche Aktivitäten zugänglich gemacht bzw. als neue Prozesse im Unternehmen etabliert werden.

#### *Befragungsbasis*

*Durchführung:* Institut für Innovationsforschung, Lehrstuhl für Technologiemanagement (Prof. Dr. Carsten Schultz) gemeinsam mit der Plattform für Innovationsmanagement (PFI/siehe Textkasten „Über die Studie“) im Jahr 2016.

*Stichprobe:* 120 größtenteils mittelständische Unternehmen (u. a. Maschinenbauer, Software-Unternehmen oder Dienstleister) mit 989 teilnehmenden Mitarbeitern; davon 46 Energieversorger (Unternehmenssitz in Deutschland bzw. vier in Österreich) mit 346 teilnehmenden Mitarbeitern. Einbezug von an Innovationen beteiligten Mitarbeitern unterschiedlicher Hierarchien und Funktionsbereiche (u. a. Marketing und Vertrieb, Unternehmensentwicklung, IT, Technik und Personalwesen).

*Charakteristika von Energieversorgern:* 93% der Energieversorger befinden sich mehrheitlich in kommunaler Trägerschaft, 65% sind in vollständig kommunaler Trägerschaft. Bezogen auf die Mitarbeiterzahl nahmen gleich viele kleinere und mittlere Stadtwerke (50%) und große Energieversorger, teils Regionalversorger, (50%) teil.

### **Innovationen tragen (noch) nicht zum Unternehmenserfolg bei**

Nur 22% der teilnehmenden Energieversorger erhöhen ihren Umsatz gegenwärtig über Innovationen und nur bei 25% der Energieversorger tragen Innovationen zur Steigerung der Profitabilität bei. Damit sind Energieversorger wesentlich schlechter aufgestellt als Unternehmen anderer Branchen. Knapp die Hälfte der Unternehmen anderer Branchen (46%) erhöht ihren Umsatz über Innovationen, während die Profitabilität bei 37% der teilnehmenden Unternehmen durch Innovationen steigt.

Ein Grund für den (noch) fehlenden Beitrag von Innovationen zum Unternehmenserfolg liegt im Innovationsgrad von Produkten, Dienstleistungen und Prozessen. Lediglich 4% der teilnehmenden Energieversorger geben an, dass ihre Produkt- und Dienstleistungsinnovationen einen hohen Innovationsgrad aufweisen. Bei 15% der Energieversorger haben Prozessverbesserungen durch neue Technologien Performancesteigerungen zur Folge.

Der Beitrag von Innovationsaktivitäten zum Unternehmenserfolg ist generell schwer messbar, besonders bei gescheiterten Projekten. Die absatzwirtschaftlichen und finanziellen Kriterien zeigen die Akzeptanz der Innovationen am Markt, spiegeln aber nicht die durch Innovationen generierten, positiven Image- und Lerneffekte wider. Um dem finanzwirtschaftlichen Erfolg und den Imageverbesserungen gerecht zu werden, sollten Energieversorger den Innovationsgrad und die Effizienz ihres Innovationsportfolios erhöhen.

### **Organisationaler Reifegrad noch auf geringen Niveau**

78% der teilnehmenden Energieversorger geben an, keine schriftlich verfasste Innovationsstrategie zu haben. Dies trifft nur auf 42% der Unternehmen anderer Branchen zu. Mit der mangelnden strategischen Ausrichtung geht eine geringe Formalisierung des Innovationsprozesses ohne klar definierte Phasen und Routinen einher. Gegenwärtig haben nur 4% der Energieversorger einen für Innovationen verantwortlichen Mitarbeiter bestimmt.

Zur Organisation von Innovationsaktivitäten sind jedoch klare Innovationsprozesse zu definieren, die gleichzeitig über eine gewisse Flexibilität verfügen müssen, um eine effiziente und effektive Durchführung zu garantieren. Dadurch ist es möglich, „beidhändig“ inkrementelle Verbesserungen und hochgradige Innovationsprojekte durchzuführen. Dies gilt insbesondere in der Energiewirtschaft, in der Energieversorger



sowohl ihr klassisches Energiegeschäft aufrechterhalten müssen, jedoch neue Geschäftsmodelle flexible und agile Unternehmensstrukturen erfordern.

Das geringe Ambitionsniveau bei innovativen Projekten, sowie der geringe Grad der Verschriftlichung und organisatorischen Verankerung von Innovationsstrategien gegenüber anderen Unternehmen belegen die insgesamt geringe Priorität von Innovationsaktivitäten gegenüber dem Tagesgeschäft. Die Etablierung einer innovationsförderlichen Kultur ist dagegen auf einem ähnlichen – allerdings sehr moderaten – Niveau wie in durchschnittlichen Unternehmen anderer Branchen.

Dies kann auf der einen Seite als positiv interpretiert werden, indem den Mitarbeitern von Energieversorgern eine Innovationsorientierung und ein kollektives Miteinander zugesprochen wird. Alternativ kann dieses Ergebnis jedoch auch eine gewisse „Wohlfühlkultur“ ausdrücken, die aufgrund des bisher bei den Mitarbeitern noch gering wahrgenommen Innovationsdruckes von Energieversorgern existiert. Dafür spricht, dass in den meisten Unternehmen der Energiewirtschaft ein sehr uneinheitliches Verständnis hinsichtlich der Relevanz von Innovationen bei den Mitarbeitern besteht.

### **Etablierung von Innovationsprozessen notwendig**

In der Gestaltung und Unterstützung des Innovationsprozesses von der Ideengenerierung bis zur Markteinführung einer Innovation weisen Energieversorger geringere Kompetenzen als Unternehmen anderer Branchen auf. Zwar betonen die Energieversorger in der Initiierung der Innovationsentwicklung ihr umfassendes Verständnis über Kunden, Mitbewerber und Märkte, jedoch fehlt ein systematischer Prozess zur Ideengenerierung, -evaluierung und -entwicklung, sodass die Integration von relevantem internen, als auch externem Wissen nur selten gelingt. Der Einsatz von IT-Tools könnte die Prozesse zur Ideengenerierung unterstützen, wird aber nur von 9% der Energieversorger genutzt. Zum Vergleich, 24% der Unternehmen anderer Branchen nutzen IT-Tools intensiv zur Ideengenerierung. Ebenso mangelt es bei Energieversorgern an einer konkreten Kommunikation für Ideen innerhalb und außerhalb der Organisation, welche die Weiterentwicklung vielversprechender Ideen vorantreibt.

Trotz der zunehmenden Verschmelzung der Energiewirtschaft mit anderen Branchen, kooperieren die meisten Energieversorger noch wenig mit externen Partnern. Positiv ist, dass Energieversorger sich intensiv mit der Entwicklung von Geschäftsmodellen auseinandersetzen. Da in vielen Energieversorgern die Abteilung für Marketing und

Vertrieb eine zentrale Rolle in Innovationsprozessen spielt, weisen die analysierten Unternehmen eine hohe Kompetenz in der Segmentierung von Märkten und Kunden sowie im Aufbau von Vertriebskooperationen auf.

### **Vier Schritte zum Aufbau eines Innovationsmanagements**

Um ein Innovationsmanagement aufzubauen, lassen sich aus den Ergebnissen dieser Studie vier zentrale Schritte für Stadtwerke und Energieversorger ableiten. Zunächst sollte im Unternehmen ein einheitliches Innovationsverständnis geschaffen werden. Dazu bedarf es einer klaren Abgrenzung der Innovationen vom Tagesgeschäft. Dies beinhaltet die Entscheidung, wie neuartig ein Prozess, ein Produkt oder eine Dienstleistung sein muss, um als Innovation behandelt und damit von den Instanzen der operativen Routine bewusst getrennt zu werden.

Darauf aufbauend sind im zweiten Schritt die Innovationsziele und Innovationsfelder des Unternehmens abzuleiten. Dies erfordert eine transparente Innovationsstrategie, die das Ambitionsniveau des Unternehmens, aber auch die Selektion und Priorisierung relevanter Innovationsprojekte darstellt. Zur Organisation der vielfältigen Innovationsaktivitäten bedarf es im dritten Schritt definierter Innovationsprozesse, die jedoch gleichzeitig über eine gewisse Flexibilität verfügen müssen, um eine effiziente und effektive Durchführung zu garantieren. Zudem müssen klare Verantwortlichkeiten für die Koordination der Innovationstätigkeit festgelegt werden.

Aufbauend auf der Etablierung von Innovationsprozessen ist im vierten Schritt eine organisatorische Verankerung der Innovationsaktivitäten erforderlich. Dies bedarf der kontinuierlichen Weiterentwicklung der Innovationsprozesse zu einem Innovationsmanagementsystem, das eine ganzheitliche Ausrichtung des Unternehmens auf Innovation gewährleistet.

### **Professionalisierung für branchenübergreifende Kooperation unabdingbar**

Anhand des Innovation Excellence Models können Unternehmen einen individuellen „Footprint“ des Innovationsmanagements erstellen und diesen mit anderen Unternehmen vergleichen, um festzustellen, in welchen Merkmalen sich die erfolgreichen von den weniger erfolgreichen Unternehmen unterscheiden. innovate! new bietet neben der systematischen Überprüfung der eigenen Innovationsmanagementkompetenz im Vergleich zu anderen Energieversorgern, einen Vergleich mit branchenfremden Unternehmen.

Bereits heute zeigen Beispiele in den Bereichen virtuelle Kraftwerke, Elektromobilität oder neuen Speichertechnologien, dass disruptive Ideen häufig einen branchenfremden Ursprung haben. Das im Sommer 2016 vom Bundestag beschlossene Gesetz zur Digitalisierung der Energiewende wird diesen Trend verstärken.

Der daraus resultierende Smart Meter Rollout und die zunehmend intelligenten Stromnetze werden von wachsenden Mess- und Prozessdaten geprägt sein, die von Internetkonzernen, Telekomunternehmen und Startups im digitalen Energiemarkt für neue Geschäftsmodelle genutzt werden. Dies wird nicht nur einen fundamentalen Strukturwandel für Energieversorger bedeuten, sondern zugleich die Herausforderung darstellen, neue datengetriebene Geschäftsmodelle mit branchenfremden Unternehmen in Business Ökosystemen zu entwickeln.

## **Article II: Produkt-Service-Systeme als Chance. Eine Analyse von Servitization-Prozessen bei Energieversorgern**

Carsten Schultz; Heiner Luetjen; Julia Kroh

*Die Bedeutung von Produkt-Service-Systemen (PSS) wächst, vor allem in produktorientierten Industrien mit zunehmend homogenen Produktangeboten. Trotz des großen Potenzials bleiben PSS in der Praxis aufgrund vieler Barrieren häufig hinter den Erwartungen zurück. Anhand einer mehrstufigen empirischen Analyse konnten strategie-, implementierungs- und ökosystem-bezogene Barrieren von Servitization-Prozessen identifiziert und notwendige Fähigkeiten von Unternehmen am Beispiel der commodity-dominierten Energiewirtschaft abgeleitet werden.*

Produzierende Unternehmen sehen sich zunehmend mit der Sättigung ihrer Kernproduktmärkte und steigenden Kundenanforderungen konfrontiert, sodass sie für Wachstum auf die Einführung von integrierten Leistungsangeboten wie Produkt-Service-Systeme (PSS) setzen. PSS können als hybride Leistungsbündel verstanden werden, die klassische Produkte eines Unternehmens mit zusätzlichen Dienstleistungen erweitern und damit Gegenstand einer interaktiven Wertschöpfung werden (Vargo und Lusch, 2008). Sie können stark produktorientiert (z. B. Wartung und Installation), nutzungsorientiert (z. B. Leasing) oder ergebnisorientiert sein, wobei die Dienstleistung sogar das klassische Produkt ablösen kann (z. B. Angebot einer Energieeffizienzdienstleistung anstatt der klassischen Energielieferung). In der Konsequenz führt die Entwicklung von Produkt-Service-Systemen zu Veränderungen auf mehreren Ebenen innerhalb des Unternehmens. Diese betreffen zum einen interne Organisationsstrukturen und damit die Anpassung etablierter Geschäftsmodelle und Unternehmensstrategien, als auch externe Faktoren, wie beispielsweise die gemeinsame Entwicklung von PSS mit externen Partnern in sogenannten Ökosystemen. Diese als Servitization bezeichnete Transformation des gesamten Unternehmens hin zu einer verstärkten Dienstleistungsorientierung gewinnt auch in der betriebswirtschaftlichen Managementforschung zunehmend an Bedeutung (Baines et al., 2009). Zudem stellt die PSS-Entwicklung Unternehmen insbesondere wegen der unterschiedlichen Eigenschaften von Produkten und Dienstleistungen vor Herausforderungen. Empirische Studien zeigen daher, dass trotz des großen Potenzials von PSS häufig finanzielle Erträge für Unternehmen ausbleiben (Gebauer et al., 2005).

## **Produkt-Service-Systeme als Chance für Energieversorger**

Die Energieversorgung als stark historisch und commodity-dominierte Branche steht exemplarisch für eine Industrie, die aufgrund wachsender Kundenanforderungen und sinkenden Margen im klassischen Vertrieb von Gas- und Stromprodukten vor der Herausforderung steht, sich zu einer dienstleistungsorientierten Branche zu wandeln. Mussten Energieversorger vor der Marktliberalisierung und der Energiewende häufig nur in einem begrenzten Umfeld aktiv sein, sind sie heute zunehmend gefordert, mit höchster Flexibilität als Energiedienstleister in smarten Wertschöpfungsnetzwerken zu agieren. Eine wesentliche Rolle spielt dabei die Digitalisierung der Energiewirtschaft. Insbesondere der ab 2017 in Deutschland geplante Rollout intelligenter Zähler und Messsysteme sowie der Einzug intelligenter Hausgeräte und vernetzter Haustechnik bieten Energieversorgern viele Kontaktpunkte zum Energiekunden, die bisher in dieser Form durch die klassische Lieferung von Strom, Gas und Wasser nicht vorhanden waren. Bereits heute erwarten laut einer aktuellen Studie über 60% der Kunden innovative Dienstleistungen im Bereich Smart Home (Oliver Wyman, 2016).

Energieversorger besitzen bereits umfassende kundenindividuelle Daten (bspw. Energieverbrauchsdaten), die künftig zur Ausdifferenzierung des Dienstleistungsangebots herangezogen werden können. Hier liegt die Chance für den intelligenten Energieversorger: Er versteht die Bedürfnisse der Kunden auch jenseits seiner althergebrachten Energieprodukte und ist in der Lage, ihnen innovative Dienstleistungen auf Basis neuer intelligenter Technologien anzubieten. Dabei sind sowohl energiebezogene Dienstleistungen als auch energieferne Dienstleistungen denkbar. Das Spektrum energiebezogener Dienstleistungen reicht von einfachen Beratungsangeboten zur Energieeinsparung, der Erstellung von Bedarfsprofilen für die Optimierung der lokalen Energiebereitstellung und des Demand-Side Management, bis hin zum Aufbau von Elektromobilitäts- und Telekommunikationsinfrastrukturen.

Die Nutzerdaten können jedoch auch in Kontexten außerhalb der Energiewirtschaft wertvolle Informationen liefern. Der Energieversorger tritt dabei als Vermittler von Dienstleistungen (Handwerkerdienstleistungen, Facility Management etc.) jeglicher Art auf. Auch Pflegedienstleistungen und andere individuelle Betreuungsdienstleistungen profitieren, da die Verbrauchsdaten eine Analyse von Verhaltensänderungen im häuslichen Umfeld ermöglichen.

Praxisrelevante Studien zeigen jedoch, dass die Digitalisierung in der Energiewirtschaft zwar angekommen ist, derzeit digitale Dienstleistungen aber keine dominante Rolle in den Geschäftsmodellen spielen (Ernst and Young, 2017). Neue branchenfremde Wettbewerber – wie Google, Apple oder Amazon – können hingegen schon heute auf vorhandene Kompetenzen in der Datenerfassung, -verarbeitung und -auswertung bauen. Wer als Versorger keine digitalen Dienstleistungsstrategien entwickelt und den Aufbau der nötigen technologischen Infrastruktur nicht finanzieren kann, droht im Zuge der digitalen Zeitenwende und damit einhergehender Marktkonsolidierungen als Marktteilnehmer auszuschneiden.

### **Empirische Studien analysieren Erfolgsfaktoren und Barrieren von Servitization-Prozessen am Beispiel der Energiewirtschaft**

Bisher finden sich in der Energiewirtschaft nur wenige Beispiele der Verzahnung von klassischen Produkten mit neuen Dienstleistungen. Noch dominiert die Ansicht, dass digitale Dienstleistungen auf Kosten der klassischen Produkte eingeführt würden und diese somit kritisch zu betrachten seien. Beispielsweise bewirkt das Angebot von Energieeffizienzdienstleistungen eine „Kannibalisierung“ klassischer Umsätze der Energielieferung, da es zu mehr Erzeugungskonkurrenz, mehr Effizienz und damit weniger Verbrauch führt. Vor diesem Hintergrund soll in diesem Beitrag aufgezeigt werden, welche Barrieren Energieversorger als häufig kommunal verankerte Unternehmen überwinden müssen, um sich zu erfolgreichen PSS-Anbietern zu wandeln. Anhand mehrerer empirischer qualitativer und quantitativer Studien (vgl. Tabelle 1), konnten die relevanten internen und externen Innovationsbarrieren sowie die notwendigen Fähigkeiten für die Etablierung von Dienstleistungsinnovationen identifiziert werden.

Zunächst wurden im Rahmen einer explorativen Studie mit 19 Energieversorgern die Entwicklungspfade und Barrieren des Servitization-Prozesses ermittelt. In einem zweiten Schritt wurde das Innovationsmanagementsystem von Energieversorgern im Vergleich zu Unternehmen anderer Branchen analysiert. Ferner wurden Sekundärdaten ausgewertet, um die Diffusion von PSS in der Energiewirtschaft abzubilden. Darüber hinaus untersuchen Fallstudien die Rolle von Energieversorgern in konkreten aus unterschiedlichen Akteuren bestehenden-Innovationsprojekten.

**Tabelle 1. Empirisches Forschungsdesign bestehend aus vier Teilstudien unterschiedlicher Forschungsmethoden**

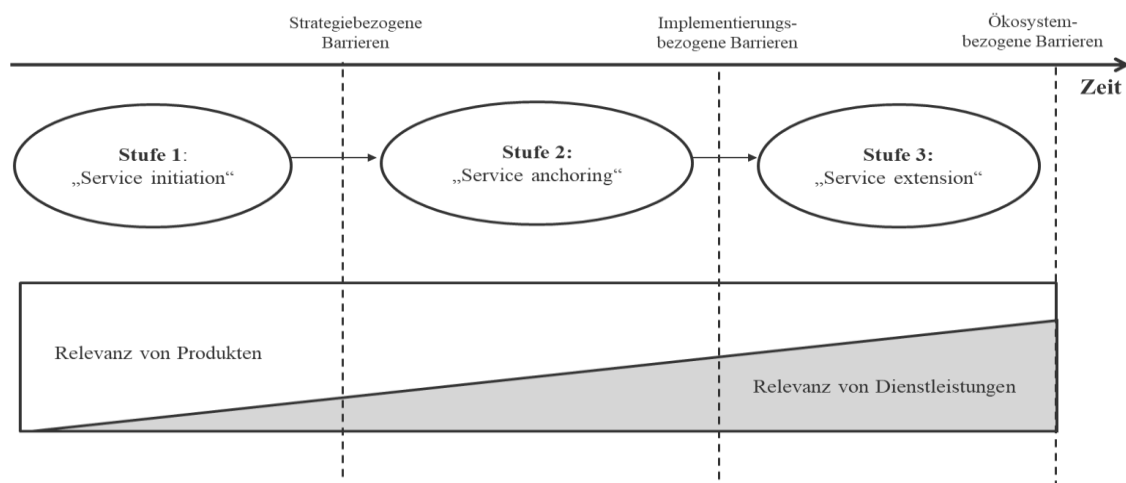
Untersuchungsgegenstand	Entwicklungspfade von PSS	Innovationsmanagementsystem	Diffusion von Services und PSS	Innovationsprojekte
<b>Forschungsmethoden</b>	Explorative Fallstudien; Semi-Strukturierte Interviews	Standardisierte Befragung	Sekundärdatenanalyse (Geschäftsberichte, Zeitungsartikel, Webseiten, Datenbanken) mit Expertenbewertung	Fallstudien (textbasierte Auswertung von Planungsunterlagen, Fragebogen)
<b>Umfang</b>	19 Energieversorger	120 Unternehmen, davon 46 Energieversorger; 989 Mitarbeiter, davon 346 Mitarbeiter von Energieversorgern	181 Energieversorger	160 Energetische Quartierskonzepte, gefördert nach KfW-Programm 432; Ziel: Steigerung der Energieeffizienz und Senkung von CO <sub>2</sub> -Emissionen in Stadtquartieren
<b>Inhalte</b>	PSS-Angebote, Servitization-Barrieren, Servitization-Prozesse	Innovationsleistung, Innovationsfördernde Rahmenbedingungen (Strategie, Kultur, Organisation) und Innovationsprozess	Bestimmung des Service-Portfolios, Bestimmung des Service-Innovationsgrads	Messung der Innovativität und Einfluss von Netzwerkstrukturen der Konzeptsteller (u. a. Energieversorger)
<b>Ergebnisse</b>	Drei Servitization-Stufen (Initiation, Anchoring, Extension); Drei Barrieren (Strategie, Implementierung, Markt und Ökosystem)	Kaum Beitrag von Innovationen zum Unternehmenserfolg; Geringer Reifegrad des Innovationsmanagements	Wenig radikale, viele inkrementelle Service-Innovationen; Hohe Varianz des Grades der Servitization	Wenig innovative Inhalte; Wenig Einfluss von Energieversorgern in Projekten auf andere Partner

### **Überwindung von Strategie-, Implementierungs- und Ökosystembezogenen Barrieren innovativer PSS**

Erfolgreiche Unternehmen durchlaufen drei aufeinanderfolgende Servitization-Stufen, die jeweils spezifische Innovationsbarrieren hervorrufen, so das Ergebnis der Untersuchung zu den Entwicklungspfaden von Services (Lütjen et al., 2017). Zu Beginn der Servitization (service initiation) sind dabei insbesondere strategische Barrieren zu überwinden. Diese betreffen unter anderem die Entscheidung, eigene Kerngeschäftsfelder zu kannibalisieren (z. B. die Reduktion des Strom- und Gasverkaufes durch Energieeffizienzdienstleistungen). In der zweiten Stufe der Servitization (service anchoring) sehen sich Energieversorger mit der schwierigen Verankerung von Dienstleistungen im Unternehmen konfrontiert. Relevante Barrieren in dieser Stufe weisen auf die Etablierung einer Innovationskultur, die Bereitstellung notwendiger finanzieller und personeller Ressourcen sowie die Entwicklung von Innovations- und

Dienstleistungsprozessen hin. In der dritten Stufe der Servitization (service extension) haben die Unternehmen größtenteils strategie-, und implementierungsbezogene Barrieren überwunden, häufig ist ein strukturierterer Innovationsprozess im Unternehmen vorhanden.

Mit einem zunehmenden Servitization-Grad steigt jedoch auch die Komplexität der Dienstleistungsentwicklung. Durch die individuellen Kundenbedürfnisse nimmt die Bedeutung der Integration des Kunden und weiterer Netzwerkakteure als externe Faktoren der Dienstleistungserstellung zu. Mit einer verstärkten Dienstleistungsorientierung gehen somit eine konsequente Verankerung der Kundenorientierung sowie ein ganzheitliches Denken unter Einbezug der nahen und fernen Unternehmensumwelt, sogenannten Ökosystemen, einher.



**Abbildung 1. Servitization-Stufen und Barrieren von Energieversorgern (in Anlehnung an Oliva and Kallenberg, 2003)**

### **Klare Innovationsstrategien zur Überwindung strategiebezogener Barrieren**

Aufgrund von Ressourcenkonflikten und Kannibalisierungseffekten zwischen Produkten und Dienstleistungen erfordert die Implementierung von PSS die Anpassung von Unternehmens- und Innovationsstrategien. Beispielsweise kann das Angebot von Energieeffizienzdienstleistungen für Energieversorger eine „Kannibalisierung“ eigener Umsätze bewirken. Somit ist es erforderlich, die notwendige Top-Management Unterstützung sicherzustellen. Die Ergebnisse der Studie zeigen, dass der Wandel von ursprünglich produktorientierten Unternehmen zu Lösungsanbietern durch extern berufene Geschäftsführer positiv beeinflusst werden kann. Die Ergebnisse legen somit für die Managementpraxis nahe, möglichst heterogene Managementteams zu etablieren, um die zunehmend komplexen PSS zu fördern.



Darüber hinaus zeigt die Untersuchung des Innovationsmanagementsystems, dass lediglich 2% der Energieversorger eine verschriftlichte Innovationsstrategie besitzen, die inhaltlich klar abgegrenzt und im Unternehmen von den Mitarbeitern wahrgenommen wird (Schultz et al., 2017). Das geringe Ambitionsniveau bei innovativen Projekten, sowie der geringe Grad der Verschriftlichung und organisatorischen Verankerung von Innovationsstrategien gegenüber anderen Unternehmen belegen darüber hinaus die insgesamt geringe Priorität von Innovationsaktivitäten gegenüber dem Tagesgeschäft. Die Basis für zielgerichtete Innovationsaktivitäten ist eine klare Innovationsstrategie. Dazu sollten Innovationen vom Tagesgeschäft abgegrenzt werden. Nur so können Innovationsfelder abgesteckt werden, in welchen das jeweilige Ambition-niveau, und damit der angestrebte Innovationsgrad und die Markteintrittsstrategie (insb. Pionier oder Folger) definiert werden. Die Ableitung der Innovationsstrategie aus der Unternehmensstrategie erleichtert die Ressourcenzuteilung für Innovationsprojekte und die Definition von Anreizen für dienstleistungsbezogene Aktivitäten der Mitarbeiter.

### **Innovationsmanagementkompetenz zur Überwindung implementierungsbezogener Barrieren**

Die Entwicklung von PSS ist dynamisch, unvorhersehbar und wenig standardisiert. Merkmale und gleichzeitig Hemmnisse innovativer PSS sind die Integration verschiedener Akteure in den Innovationsprozess und die damit einhergehenden erheblichen Veränderungen der bestehenden Wertschöpfungs-systeme. Im Gegensatz zu reinen Produkten sind durch zentrale Dienstleistungsbestandteile gekennzeichnete PSS intangibel, heterogen, untrennbar und kurzlebig (Fitzsimmons und Fitzsimmons, 2008). PSS werden vor allem auf Basis von Informationsprozessen zwischen Mitarbeitern und in einem interaktiven Prozess mit dem Kunden und weiteren externen Partnern erbracht, sodass die erbrachte Leistung aufgrund unterschiedlicher Kundenanforderungen variiert. Die Bereitstellung von PSS ist demnach komplexer als die reine Produkterstellung und macht den Kunden zum Koproduzenten.

Die empirischen Ergebnisse weisen hinsichtlich der Gestaltung und Unterstützung des Prozesses von der Ideengenerierung bis zur Markteinführung einer Innovation geringe Kompetenzen bei Energieversorgern auf. Zwar betonen sie in der Initiierung der Innovationsentwicklung ihr umfassendes Verständnis über Kunden, Mitbewerber und Märkte, jedoch fehlt ein systematischer Prozess zur Ideengenerierung, -evaluierung und -entwicklung, sodass die Integration von relevantem internen und externem Wissen nur

selten gelingt. Ebenso mangelt es an einer ausgeprägten Kommunikation für Ideen innerhalb und außerhalb der Organisation, welche die Weiterentwicklung vielversprechender Ideen vorantreiben könnte. Ferner zeigen sich im Gegensatz zu Unternehmen anderer Branchen eine schwache IT-Unterstützung und die mangelnde Integration externer Partner in Innovationsprozessen.

Für Energieversorger erweist es sich als sinnvoll, Instrumente zur Informationsbeschaffung und Verarbeitung zu nutzen, um die funktionalen Anforderungen an PSS gemeinsam mit den Kunden und komplementären Leistungsanbietern zu bestimmen. Die aktive Einbeziehung von Kunden in den Innovationsprozess sowie die Ausrichtung von Prozessen am Kunden erweisen sich als Schlüsselfaktoren für die Implementierung. Der Bedarf, eine hohe Variantenvielzahl zu berücksichtigen und das Denken in Systemen zu fördern, erschwert die Entwicklung der PSS. Grundlage dessen ist oft eine möglichst frühzeitige Modellierung und ggf. Simulation von komplexen Dienstleistungsangeboten. Um die Prozesse zu modellieren, können unterschiedliche Ansätze des Service Engineering genutzt werden. Dabei können Methoden, Instrumente und Werkzeuge aus der Produkt- und Softwareentwicklung (z.B. Service Blueprinting, Fehleranalysen) übertragen werden, um eine systematische Entwicklung und einen frühzeitigen Test von Dienstleistungen zu gewährleisten und Fehler zu vermeiden.

### **Kooperationsaufbau zur Überwindung ökosystembezogener Barrieren**

Um innovative PSS zu entwickeln und anzubieten, müssen Energieversorger eine Vielzahl zu integrierender Komponenten und benötigter Kompetenzen in einem Netzwerk aus verschiedenen Partnern verknüpfen. Innovationen in der Energiewirtschaft involvieren Multiakteurs-Netzwerke und bedürfen daher einer Innovationsökosystem-Perspektive. Sie integrieren Akteure sowohl auf Zulieferseite (upstream) als auch auf Marktseite (downstream) der Wertschöpfungskette (Teece, 2016) und berücksichtigen neben der Notwendigkeit externer Ressourcen auch die Existenz zusätzlicher Anspruchsgruppen an die durch das Unternehmen geschaffenen Werte (Barney, 2017).

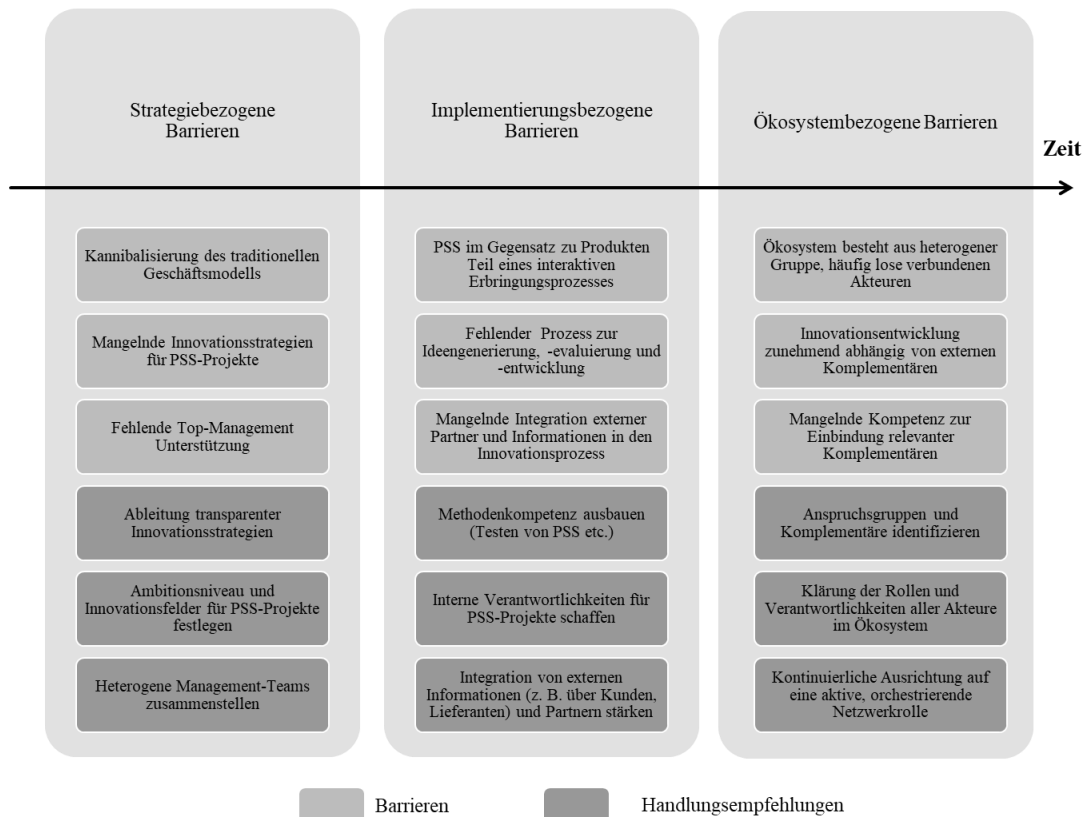
Diese Perspektive reflektiert die Interdependenz der zu entwickelnden PSS von den direkt verbundenen Kooperationspartnern (z.B. Zulieferer, komplementäre Dienstleistungsanbieter, Kunden) und von einem heterogenen und nur lose verbundenen Netzwerk an Akteuren. Dieses Netzwerk umfasst z.B. die lokale Verwaltung und Wirtschaftsförderung, Infrastrukturanbieter, die Politik, Unternehmens- und

Verbraucherschutzverbände, Bildungs- und Forschungseinrichtungen sowie andere Akteure die Kontrolle über öffentliche Ressourcen ausüben. Das Zusammenwirken der privatwirtschaftlichen und öffentlichen Organisationen resultiert in einer dynamischen-evolutionären und lokal verankerten Entstehung von Innovationen, wobei die Koordination durch geteilte Institutionen, inkl. gemeinsamer Wertvorstellungen und Zielsetzungen, erfolgt (Adner und Kapoor, 2010). Daher ist der Innovationserfolg von PSS maßgeblich durch die Bereitschaft und Fähigkeit der externen Akteure geprägt, komplementäre Innovationsaktivitäten zu erbringen (Vargo und Lusch, 2011).

Die Untersuchung im Quartierskontext zeigt, dass Energieversorger bisher selten eine aktive – orchestrierende – Rolle in akteursübergreifenden Ökosystemen einnehmen. Intelligente Energiedienstleistungen in der Wohnungswirtschaft sind jedoch nur möglich, wenn auch die lokalen Telekommunikationsanbieter und Immobilienunternehmen komplementäre Innovationsprojekte starten, um z.B. die Nutzung der Energiedaten technisch zu ermöglichen und in die eigenen operativen Prozesse zu integrieren. Lediglich einige wenige Innovationsführer nutzen ihre lokale Verankerung für den Ausbau ihres Dienstleistungsangebots über reine Energiethemen hinaus und bringen sich federführend in die Konzepterstellung und Projektsteuerung zur Energieeffizienzsteigerung ein. Aktiv sind dabei vor allem die Unternehmen, die ihr Netzwerk aktiv managen und alle Partner in die Dienstleistungsentwicklung integrieren können. Energieversorger besitzen zwar die Kompetenz, ihre Daten für den eigenen Betrieb der Energienetze auszuwerten, allerdings mangelt es an der Kompetenz zur Nutzung der Daten im energiefernen Kontext. Kooperationen können diese Wissenslücke schließen und sind somit insbesondere für energieferne Dienstleistungen im Zusammenhang mit der Nutzung kundenindividueller Daten relevant.

### **Interner und externer Strukturwandel als Basis innovativer Produkt-Service-Systeme**

Die Abbildung 2 fasst die strategie-, implementierungs- und ökosystembezogenen Barrieren der Entwicklung und Einführung von PSS und die daraus abgeleiteten Handlungsempfehlungen zusammen.



**Abbildung 2. Potenziale und Barrieren aus interner Perspektive und aus Sicht des Unternehmensumfeldes bei Energieversorgern**

Die Entwicklung von innovativen PSS beruht auf einer ganzheitlichen Verknüpfung heterogener Leistungsbestandteile und damit einer engen Vernetzung mit Kunden und externen Wertschöpfungspartnern. Die damit einhergehenden organisatorischen Veränderungsprozesse bedürfen der Entwicklung und Implementierung einer dienstleistungsorientierten Unternehmens- und Innovationsstrategie. Die spezifischen Barrieren bei der Implementierung von PSS müssen im Innovationsmanagement abgebildet sein, das Kunden und externe Partner aktiv einbindet. Aufgrund der Heterogenität und Individualität der Dienstleistungen gehen die Partnerschaften jedoch über klassische Zulieferbeziehungen hinaus und involvieren lose gekoppelte Ökosysteme. Dazu bedarf es neuer Innovationsprozesse, die eine Integration der Kunden und weiterer externer Partner sicherstellen, obwohl diese in der Regel kein Eigentum an den verwendeten Produkt-Service-Systemen erwerben und oft nur mittelbar von den Effekten betroffen sind. Dabei spielt der Einbezug aller Nutzergruppen als Koproduzenten und die Förderung kollektiver Lernprozesse eine zentrale Rolle. Energieversorger haben aufgrund ihrer verfügbaren Daten vielfältige Potenziale, um in einem branchenübergreifenden Netzwerk die Rolle des Orchestrators, also die eines Daten- und Dienstleistungsvermittlers

mit Steuerungskompetenz einzunehmen. Sie sollten daher den stattfindenden Strukturwandel nicht nur als Gefahr für traditionelle Kernmärkte ansehen, sondern die Gelegenheit nutzen, neue Geschäftsfelder zu entwickeln und sich mittels innovativer Dienstleistungen am Markt neu zu positionieren.

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### **Article III: Energetische Quartierssanierung: Energieversorger nutzen Potenziale für branchenübergreifende Innovationsprozesse zu wenig**

Julia Kroh; Carsten Schultz

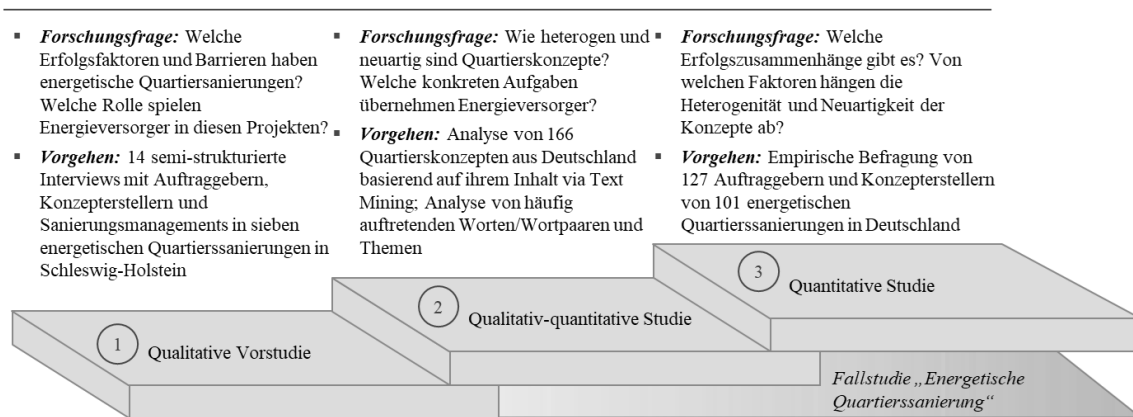
*Die energetische Optimierung von Stadtvierteln, die Quartierssanierung, bietet Energieversorgern die Möglichkeit, ihr Dienstleistungsportfolio um energienahe und -ferne Services zu erweitern. Noch treiben Energieversorger diese Quartierssanierungen selbst wenig voran und überlassen anderen, oft nicht lokalverankerten Akteuren wie Energieagenturen und Ingenieurbüros die Federführung in der Entwicklung neuer Wärme- oder Mobilitätsinfrastrukturen. Energieversorger werden zwar bei Bedarf als Umsetzungspartner für bspw. Fern- und Nahwärmelösungen hinzugezogen, verlieren damit aber ein wichtiges Instrument zur Stärkung der Kundenbindung und zur Erweiterung ihres Geschäftsmodells um innovative Dienstleistungen.*

Die Erfüllung der Klimaschutzziele, angetrieben durch die Bundesregierung, bedingt eine sich ändernde Struktur der Energieerzeugung und Energienutzung in Deutschland, die zur Kannibalisierung von Teilen des Kerngeschäftes energieversorgender Unternehmen führt. So ermöglicht die dezentrale Energieerzeugung es dem Kunden, über erneuerbare Energieträger den klassischen Versorger in der Bereitstellung von Strom zu umgehen: Das Mieterstrommodell bspw. zeigt, wie der Energieversorger den wertvollen Kundenzugang verliert, indem der Kunde seinen eigenen Strom erzeugt und selbst oder über Drittanbieter verwaltet.

Die Teilnahme an Projekten wie der energetischen Stadtsanierung (Bundesinstitut für Bau-, Stadt- und Raumforschung, 2018), einem vom Bund initiiertem Förderprogramm zur Energieeffizienzsteigerung und CO<sub>2</sub>-Reduzierung in Quartieren, bietet Energieversorgern die Möglichkeit, die über den Kunden gesammelten Informationen zu nutzen, um den Kunden mit z.B. integrierten smarten Quartierslösungen weiterhin an sich zu binden und mit einem neu ausgerichteten Geschäftsmodell wettbewerbsfähig zu bleiben. Das Programm unterstützt den Wandel vom klassischen Wohnquartier zu einem nachhaltigen und zukunftsfähigen Stadtviertel sowie vom Kunden als Verbraucher zum Kunden als Prosument, dem produzierenden Konsumenten.

Ziel der Studie der Christian-Albrechts-Universität zu Kiel ist die Identifikation von Erfolgswahrscheinlichkeiten in der energetischen Quartierssanierung als Beispiel für ein branchenübergreifendes Innovationsprojekt im urbanen Raum (Abbildung 1). Energetische

Quartierssanierungen werden dabei als offene Innovationsprozesse verstanden, in denen unterschiedliche Interessensgruppen für die Umsetzung der Innovationen in einem lokal begrenzten Raum relevant sind. Daher sollten energetische Quartierssanierungen die Erarbeitung von innovativen und quartiersspezifischen Maßnahmen fokussieren und unter Einbezug möglichst vieler Interessensgruppen ein breit aufgestelltes Quartierskonzept formulieren. Es bleibt anzunehmen, dass Quartierskonzepte in Abhängigkeit von der Art der integrierten Interessensgruppe unterschiedlich heterogen bzw. neuartig sind. Auf Basis einer Analyse von 166 Quartierskonzepten und der Befragung von 127 Projektverantwortlichen zeigt sich, dass Quartierskonzepte zwar häufig vielfältige Themen vereinen, aber hinter ihrem Innovationspotenzial insbesondere im Hinblick auf integrierte Smart-City-Lösungen zurückbleiben. Energieversorger nutzen relativ selten die Gelegenheit zur aktiven Steuerung dieser Innovationsprojekte.



**Abbildung 1. Über die Studie „Energetische Stadtsanierung“**

### **Konzepte inhaltlich breit angelegt, aber wenig innovativ**

Energetische Stadtsanierungen haben das Ziel, Stadtstrukturen ausgehend von Stadtvierteln nachhaltig und zukunftsfähig zu gestalten. Dazu entwickelt ein aus unterschiedlichen kommunalen und privatwirtschaftlichen Organisationen wie Kommunen, Energieagenturen, Energieversorgern und Immobilienunternehmen bestehendes Projektteam ein Quartierskonzept, das bspw. über Maßnahmen in den Bereichen Gebäudesanierung, Wärmeversorgung, erneuerbare Energien und Mobilität einen integrierten Ansatz zur Steigerung der Energieeffizienz liefert. Bisher sind Energieversorger in der Initiierung von Quartierskonzepten allerdings eher zurückhaltend: Nur in 15% der untersuchten Quartierskonzepte sind Energieversorger im Projektteam federführend (basierend auf der quantitativen Studie, siehe Abbildung 1). Auch wenn

Energieversorger aufgrund ihrer kommunalen (Teil-) Eigentümerstruktur die Förderung beantragen dürften, werden Quartierskonzepte größtenteils von Gemeinden und Kommunen angestoßen. In knapp der Hälfte der Quartiere sind Energieversorger allerdings im Projektteam vertreten und in weiteren 24% werden sie für konkrete Fragestellungen vom Projektteam hinzugezogen.

Die 101 im Rahmen der Studie quantitativ untersuchten Quartiere stammen aus 15 Bundesländern in Deutschland, wobei ein Quartier im Mittel 4700 Einwohner umfasst. Die Studie deckt sowohl Quartiere in Großstädten als auch in kleineren und ländlichen Regionen ab. Neben den häufigsten Handlungsfeldern Gebäudesanierung und Wärmeversorgung beinhalten 91% der Quartierskonzepte Maßnahmen zum Einsatz erneuerbarer Energien und knapp zwei Drittel der Quartierskonzepte Vorschläge für ein klimafreundliches Verbrauchsverhalten der Anwohner. Nur die Hälfte der Konzepte integriert Vorschläge für ein neues Mobilitätssystem im Quartier und ein Viertel der Konzepte geht mit Maßnahmen zu bspw. Barrierefreiheit über den Standard der vom Fördergeber vorgegebenen Handlungsfelder hinaus. Fast die Hälfte der untersuchten Quartierskonzepte enthält fünf und mehr Handlungsfelder, 8% beinhalten zwei oder nur ein Handlungsfeld. Nur 28% der Quartiere geben an, Maßnahmen über den vom Fördergeber geforderten Standard hinaus zu entwickeln. Die untersuchten Quartierskonzepte erfüllen damit zwar den Anspruch, breit aufgestellt zu sein, sind untereinander aber relativ ähnlich und vernachlässigen größtenteils integrierte smarte Lösungsansätze zur Steigerung der Energieeffizienz.

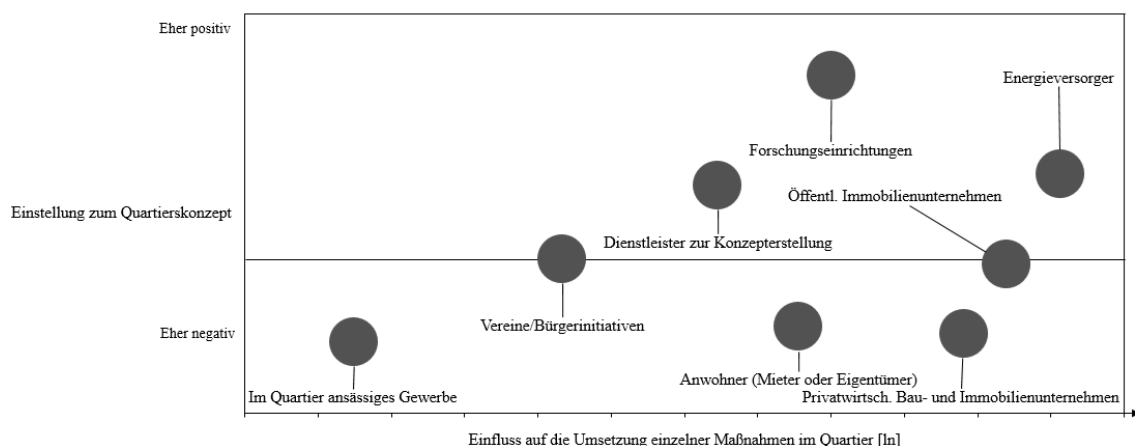
Das Quartierskonzept ist der Abschluss der frühen Phase des Innovationsprozesses, der Ideensammlung, -bewertung und -auswahl, und wird anschließend im Stadtviertel unter Einbezug unterschiedlicher Interessensgruppen umgesetzt. Im Durchschnitt werden in den untersuchten Quartierskonzepten zehn unterschiedliche Interessensgruppen eingebunden, wobei knapp ein Fünftel der Quartierskonzepte weniger als fünf Interessensgruppen integriert und 17% der Quartierskonzepte mehr als 15 unterschiedliche einbinden. Viele dieser Interessensgruppen sind lokale Akteure wie Anwohner und Gewerbe zu denen Energieversorger bereits eine hohe Vertrauensbasis und starke Kundenbindung aufgebaut haben. Energieversorger können im Quartier sowohl Ideen entwickeln als auch die Umsetzung bereits entwickelter Ideen übernehmen. Aktuell führen sie im Quartier oft aber nur Energieberatungen durch und bieten Contracting und Nah- und Fernwärmelösungen an. Damit treten Energieversorger wenig innovativ auf, vernachlässigen den Ausbau



bestehender Kundenbindungen und geben (auch branchenfremden) Konkurrenten die Möglichkeit zum Markteinstieg. Viel eher sollten Energieversorger das Potenzial von Quartieren als Träger innovativer Lösungen im Energiebereich wahrnehmen: Im Quartier bieten sich zahlreiche Möglichkeiten für smarte Services und integrierte selbstorganisierte Lösungen wie ein autonomes Mobilitätssystem.

### Energieversorger mit begrenztem Einfluss in einem heterogenen Netzwerk

Die Ergebnisse der quantitativen Studie zeigen, dass Energieversorger von den Konzepterstellern in Quartierskonzepten als positiv eingestellt und mit relativ großem Einfluss auf die Umsetzung entwickelter Maßnahmen wahrgenommen werden (Abbildung 2). Dies bestätigt die Schlüsselrolle von Energieversorgern im Quartier im Allgemeinen, derzeit aber vor allem in der Etablierung einer neuen Quartierswärmestruktur, einem Handlungsfeld, das 93% der Quartiere im Konzept integrieren. Ähnlich viel Einfluss auf die Umsetzung einzelner Maßnahmen im Quartier hat laut den Konzepterstellern die Wohnungswirtschaft, vertreten durch kommunale und privatwirtschaftliche Wohnungsunternehmen. Insbesondere für die Umsetzung von Maßnahmen im Bereich der Gebäudesanierung wie Dämmmaßnahmen oder der Integration von intelligenter Haussteuerung, die 96% der Quartiere im Konzept integrieren, ist die Wohnungswirtschaft unerlässlich. Im Quartier ansässiges Gewerbe wie Handwerker und Industrie haben nur wenig Einfluss auf die Umsetzung und sind zudem dem Konzept gegenüber skeptisch eingestellt. Für den Großteil der untersuchten Quartierskonzepte sind diese Akteure daher wenig relevant.



**Abbildung 2. Interessensgruppen nach ihrer Einstellung zum Quartierskonzept und ihrem Einfluss auf die Umsetzung des Quartierskonzeptes**

Trotz ihrer positiven Wahrnehmung im Quartierskonzept werden Energieversorger weniger intensiv als andere Interessensgruppen in den Konzepterstellungprozess integriert. Bei 50% der Quartierskonzepte wird mit Energieversorgern in der frühen Phase der Konzepterstellung intensiv kooperiert. Die Einbindungsintensität nimmt über den Prozess der Konzepterstellung ab: In der Maßnahmengenerierung bindet nur noch ein Viertel der Quartiere Energieversorger intensiv ein, während die Entscheidung über die Aufnahme von Maßnahmen in das Konzept nur in 13% der Quartiere von Energieversorgern beeinflusst werden kann. Energieversorger scheinen zwar für die Umsetzung wichtig zu sein, haben aber aktuell wenig Einfluss auf das Ergebnis des Quartierskonzepts, denn Quartiere, bei denen Energieversorger intensiv einbezogen werden, sind nicht technologisch neuartiger und inhaltlich breiter aufgestellt als Quartiere, bei denen Energieversorger nicht intensiv einbezogen werden. Allerdings gehen Konzepte, in denen sie intensiv einbezogen werden, über die vom Fördergeber geforderten Standards hinaus.

Die Ergebnisse der Studie zeigen, dass andere Interessensgruppen sehr wohl das Ergebnis beeinflussen können: Quartierskonzepte sind technologisch besonders neuartig, wenn Dienstleister wie Energieagenturen oder Ingenieurbüros intensiv in den Erstellungsprozess eingebunden sind. Hier profitiert das Konzept von dem Wissen und der Erfahrung der Akteure aus anderen Projekten. Quartierskonzepte verlieren dagegen an inhaltlicher Breite, wenn Akteure aus der Politik intensiv eingebunden werden. Die Gemeinde oder Kommune sind häufig Auftraggeber der Quartierskonzepte und haben deshalb eine genaue Vorstellung der im Quartier anzustrebenden Veränderungen. Damit geht allerdings oft der Blick auf das große Ganze und innovativere Lösungsmöglichkeiten verloren.

In energetischen Quartierssanierungen werden Interessensgruppen eher über klassische Kanäle integriert. Drei Viertel der Quartiere informieren relevante Interessensgruppen in Vorträgen, die Hälfte nutzt Printmedien, Diskussionsrunden, Workshops, Flyer, Plakate und Quartierszeitungen für die Ansprache von Interessensgruppen. Nur ein Viertel nutzt die sozialen Medien zur Ideengenerierung, noch weniger Quartiere (4%) haben ein eigenes Online-Forum, in dem die breite Öffentlichkeit Ideen für die Quartierssanierung einbringen kann. Immerhin 40% verfügen über eine eigene Homepage, auf der sie über die Konzepterstellung und den Fortschritt der Umsetzung informieren. Ebenfalls 40% der Quartiere haben das fertige Konzept mit den

relevanten Interessensgruppen und der breiten Öffentlichkeit diskutiert. Zukünftig sollte für die Integration von Interessensgruppen vermehrt auf Informationstechnologien beruhende Kanäle zurückgegriffen werden, da so der Grundstein für smarte Services gelegt werden kann.

### **Energieversorger sollten sich stärker lokal und innovativ einbringen**

Energieversorger haben aufgrund der ihnen verfügbaren Daten vielfältige Potenziale, um in einem branchenübergreifenden offenen Netzwerk wie dem Quartier die Rolle des Orchestrators zu übernehmen. Die Ver-, Übermittlung und Steuerung von Daten und Dienstleistungen in einem breiten Netzwerk kann so das neue Kerngeschäft von Energieversorgern werden. Das Quartier ist die Plattform für vielfältige Informationen, auf deren Basis unterschiedliche Dienstleistungsinnovationen angeboten werden können. Energieversorger können ausgehend von Projekten wie der energetischen Quartierssanierung die eigenen Kompetenzen in bspw. Energiemanagement und -beratung in anderen Branchen anbieten und Kompetenzen aus anderen Industrien wie Facility-Management in den eigenen Markt übertragen. Diese energienahen Dienstleistungen, die wie Energieberatungen im Bezug zur angebotenen Energie stehen, oder energiefernen Dienstleistungen, die wie Telekommunikations- und Mobilitätsangebote wenig Bezug zum aktuellen Kerngeschäft haben, erfordern zwar die Zusammenarbeit mit externen, teils unbekanntem Partnern, bieten aber im Gegenzug eine nachhaltigere und tiefere Kundenbindung (Wagner und Kristof, 2001). Darüber hinaus sind die im Quartier gewonnenen Informationen auch wertvoll für interne Dienstleistungen wie ein digitales Asset Management, z.B. für die Optimierung der Wartung in Energie- und Wasserwirtschaft.

Um innovative Dienstleistungen anbieten zu können, sind Energieversorger auf Innovationskooperationen angewiesen, um fehlende Ressourcen auszugleichen und einen frühen Markteinstieg zu gewährleisten. In Quartieren könnten Energieversorger Kooperationen mit anderen lokalen ohnehin schon bekannten Akteuren wie Stadtplanung, Wohnungsunternehmen, Energieberatungen, öffentlichen Institutionen und weiteren im Quartier ansässigem Gewerbe nutzen, um branchenübergreifende Plattforminnovationen im Quartier anzustoßen. Derzeit führen Energieversorger zwar viele Innovationsprojekte (im Schnitt 21) durch und zeigen damit den Willen zur Erneuerung (Schultz et al., 2017).

Die Innovationsprojekte werden allerdings vor allem in klassischen Gebieten wie dem Infrastrukturausbau durchgeführt, sind oft wenig innovativ, gehen selten über die Grenzen

des traditionellen Energiemarktes hinaus und werden wenig in Kooperation mit Markt- und Vertriebspartnern und Forschungseinrichtungen durchgeführt.

In Quartierssanierungen sollten Energieversorger sich zukünftig stärker mit Hilfe von Kooperationen einbringen, um die im Quartier bereitgestellten Informationen intern und extern für innovative Dienstleistungen zu nutzen.

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## **Article IV: Studie der Uni Kiel: Wann sind Quartiere innovativ? Neue Energiedienstleistungen im Quartier**

Julia Kroh; Carsten Schultz

*Die Universität Kiel hat in einem Forschungsprojekt über vom Bund geförderte energetische Quartierssanierungen 168 Quartiere in Deutschland auf ihre Innovativität untersucht. Das Ergebnis: Obwohl innovative Quartierslösungen entscheidend für die Nachhaltigkeit und damit Zukunftsfähigkeit des städtischen Raums sind, erhalten sowohl technologisch als auch in der Quartiersorganisation bisher weniger innovative Lösungen häufig den Vorzug.*

Weltweit wachsen Städte aufgrund des Bevölkerungsanstiegs und dem Trend zur Urbanisierung. Besondere Herausforderungen finden sich dabei im nachhaltigen Wachstum beziehungsweise in der nachhaltigen Transformation des aktuellen Gebäudebestands und der Infrastruktur. In diesem Kontext findet in Deutschland urbane Innovationen, das heißt Neuerungen im städtischen Raum, deshalb oft mit den Zielen Energieeffizienzsteigerung und CO<sub>2</sub>-Reduzierung statt. Knapp die Hälfte der untersuchten Quartierssanierungen entwickelt Lösungen, die zur ökonomischen, ökologischen und sozialen Nachhaltigkeit des Quartiers beitragen. Die Umsetzung von Produkt- und Dienstleistungsinnovationen ist in Städten allerdings an viele Kontingenzfaktoren wie zum Beispiel die lokale Akzeptanz (durch Anwohner, Einzelhandel, Gewerbe) oder städtische Strukturen gebunden. Dies macht Innovationen in Städten wesentlich risikoreicher, ertragsärmer und kooperationsbedürftiger und damit insgesamt weniger vergleichbar mit Produkt- oder Dienstleistungsinnovationen in anderen Märkten.

### **Quartiere als Träger der Energiewende**

Der städtische Raum bietet trotzdem Potenziale für vielversprechende neue Energiedienstleistungen wie Carsharing oder Mieterstrommodelle, denn deutsche Städte müssen nicht zuletzt durch die von der Bundesregierung vorgegebenen Klimaschutzziele nachhaltiger und zukunftsfähiger werden. Laut Umweltbundesamt entfiel 2016 etwas über die Hälfte der verbrauchten Energie in Deutschland auf die Sektoren „Verkehr“ (30%) und „Haushalt“ (26%). Damit rückt die Neugestaltung von Stadtvierteln und Quartieren, als kleinste Einheit des städtischen Raums, unmittelbar in den Fokus der Energiewende. Das in dieser Studie untersuchte Förderprogramm „Energetische Stadtsanierung“ unterstützt die Entwicklung und Umsetzung von Maßnahmen in den Handlungsfeldern Gebäudesanierung, Wärmeversorgung, erneuerbare Energien, Mobilität und

Verbrauchsverhalten und damit einen integrierten Ansatz zur Entwicklung und Umsetzung von urbanen Innovationen in Quartieren. Diese werden von einem heterogenen Projektteam, bestehend aus unterschiedlichen kommunalen und privatwirtschaftlichen Organisationen wie Kommunen, Energieagenturen, Energieversorgern und der Wohnungswirtschaft, entwickelt.

Die Zukunftsfähigkeit eines Quartiers lässt sich am ehesten mit auf das Quartier zugeschnittenen, innovativen Lösungen erreichen. Die Integration von Maßnahmen, die über die vom Fördergeber vorgegebenen Standards hinausgehen, marktaktuelle Technologien und innovative Quartiersorganisation unterstützen beispielsweise die Akzeptanz im Quartier, welche wiederum die Umsetzungswahrscheinlichkeit erhöht. Allerdings bewerten nur knapp 28% der befragten Konzeptsteller und Auftraggeber von 101 Quartierskonzepten das von ihnen erstellte Konzept als technologisch innovativ beziehungsweise sehr innovativ. Die Analyse der 168 Quartierskonzepte via Text Mining unterstützt diese Selbsteinschätzung: Nur knapp ein Viertel der Konzepte kann insgesamt als innovativ bewertet werden. Abbildung 1 verdeutlicht dies mit einer Übersicht der häufigsten Maßnahmen pro Handlungsfeld. Dort zeigt sich zusätzlich, dass digitale Energiedienstleistungen, die zum Beispiel über die in intelligente Messsystemen gewonnenen Daten entwickelt werden, stark unterrepräsentiert sind. Auch weitere digitale Anwendungen wie Smart Home sind ebenso nur selten in die Quartierslösungen integriert wie soziale Aspekte wie altersgerechtes und barrierefreies Wohnen.

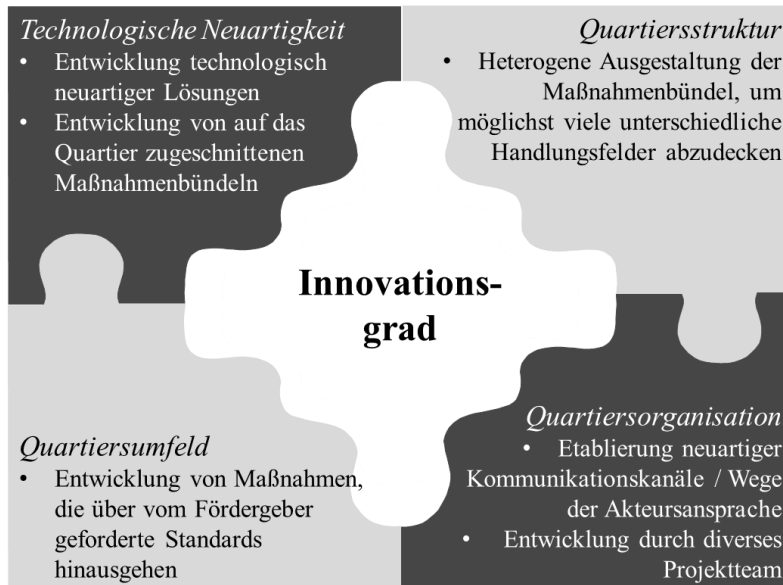
<ul style="list-style-type: none"> <li>▪ Gebäudesanierung                             <ul style="list-style-type: none"> <li>▪ Dämmung von Dächern, Geschossdecken, Innen- und Außenfassaden</li> <li>▪ Austausch von Fenstern</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>▪ Wärmeinfrastruktur                             <ul style="list-style-type: none"> <li>▪ Ausbau von Fernwärme und Nahwärmenetzen</li> <li>▪ Kopplungsanlagen wie BHKW's</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>▪ Öffentlichkeitsarbeit                             <ul style="list-style-type: none"> <li>▪ Energieberatung</li> <li>▪ Informationsveranstaltungen/-kampagnen</li> <li>▪ Mustersanierungen und Gebäudesteckbriefe</li> </ul> </li> </ul>
<ul style="list-style-type: none"> <li>▪ Verbrauchsverhalten                             <ul style="list-style-type: none"> <li>▪ Nutzerverhalten (Lüftverhalten, Standby-Modus) und Energiemonitoring</li> <li>▪ Sensibilisierung</li> <li>▪ Haushaltsgerätecheck</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>▪ Erneuerbare Energien                             <ul style="list-style-type: none"> <li>▪ Solarthermie</li> <li>▪ Photovoltaik-Anlagen</li> <li>▪ Biomasse</li> <li>▪ Geothermie</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>▪ Mobilität                             <ul style="list-style-type: none"> <li>▪ ÖPNV</li> <li>▪ Elektromobilität und Ladeinfrastruktur</li> <li>▪ Rad-/Fußverkehr; E-Bike-Sharing</li> <li>▪ Carsharing</li> </ul> </li> </ul>

**Abbildung 1. Häufigste Maßnahmen nach Handlungsfeld**

### **Integration innovativer Technologie ist nicht genug**

Die technologische Neuartigkeit allein ist nicht zur Bewertung der Innovativität eines Quartierskonzeptes ausreichend. Vielmehr ist der Innovationsgrad eines Quartierskonzeptes dann hoch, wenn die entwickelten Maßnahmen einzigartig auf das Quartier zugeschnitten sind. Damit geht einher, dass das Konzept inhaltlich breit aufgestellt ist und über die vom Fördergeber geforderten Standards hinausgeht. Erreichen lässt sich dies mit einer möglichst heterogenen Akteursstruktur im Projektteam, die den komplexen Strukturen der Quartiere gerecht wird. Hier unterstützt ein professionelles Projektmanagement die Entwicklung urbaner Innovationen.

Zur Bewertung der Quartiersinnovativität sind neben der technologischen Neu- und Einzigartigkeit der Quartierslösungen die Veränderung der Quartiersstruktur, die Neuartigkeit der Quartiersorganisation durch beispielsweise neuartige Kommunikationswege sowie die Stärke des Einflusses auf die Quartiersumwelt relevant (Abbildung 2). Heterogene Quartierslösungen, also Lösungen, die mit vielen Maßnahmen unterschiedliche Handlungsfelder wie Mobilitätsservices und den Einsatz erneuerbarer Energien bedienen, unterstützen die Akzeptanz im Quartier. Im Schnitt sind Quartierskonzepte breit aufgestellt, denn ein Quartierskonzept der 168 via Text Mining untersuchten Quartierskonzepte enthält im Mittel 18 Maßnahmen in vier Handlungsfeldern. Allerdings bestätigen nur 20% der befragten Quartiere, dass die von ihnen entwickelten Maßnahmen akzeptiert sind. Ein möglichst heterogenes Projektteam kann zum einen innovative Technologien integrieren und zum anderen innovativere Wege schaffen, über die Anwohner und weitere Interessensgruppen in den Prozess der Konzepterstellung einbezogen werden. 34% der via Text Mining untersuchten Quartiere haben drei oder mehr unterschiedlichen Organisationen erstellt. Universitäten und andere Forschungseinrichtungen, also Organisationen, die in der Regel innovative und ungewöhnliche Lösungen einbringen, sind allerdings nur in weniger als 10% der Projekte in die Konzepterstellung integriert. Dies zeigt sich auch in der Wahl einer innovativen Quartiersorganisation: Nur ein Drittel der in der Umfrage befragten Konzeptersteller gibt an, neue Kommunikationswege im Quartier geschaffen zu haben. Weniger als 30% der befragten Quartiere gehen stark über die vom Fördergeber vorgegebenen Standards hinaus und überschreiten damit die vom Umfeld vorgegebenen Regularien.



**Abbildung 2. Bewertung des Innovationsgrades basierend auf vier Dimensionen**

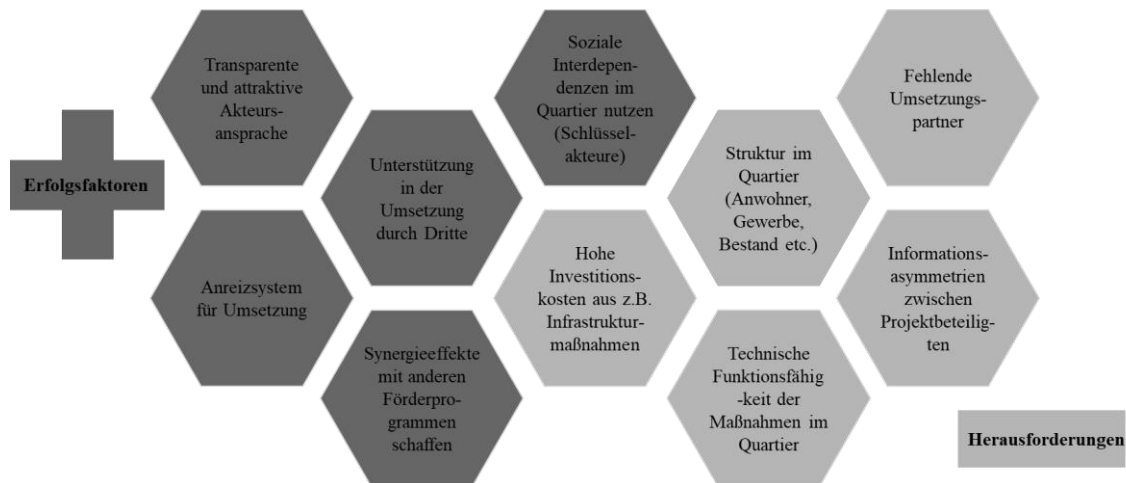
### **Innovativität als mögliches Umsetzungshemmnis**

Ein Großteil der Konzeptsteller empfindet eine hohe Innovativität insbesondere bei technologisch neuartigen Lösungen als Hemmnis für die Umsetzung im Quartier (Abbildung 3). Innovative Lösungen sind allerdings per se kein Umsetzungshindernis, sondern benötigen ein strukturiertes Umsetzungsmanagement, um alle Akteure im komplexen System „Quartier“ zu integrieren und von der Sinnhaftigkeit der erarbeiteten Maßnahmen zu überzeugen. Neue Dienstleistungen wie Energieberatung, -Management oder Contracting können an dieser Stelle Vorteile für Anwohner und Unternehmen wie Energieversorger schaffen: Anwohner umgehen hohe Investitionen in beispielsweise neue Heizanlagen, Energieversorger erweitern ihr Kerngeschäft um Dienstleistungen und sichern sich damit über eine langfristige Kundenbindung nachhaltige Wettbewerbsvorteile. Das Potenzial von Quartieren als mögliches Geschäftsfeld neuer digitaler Energiedienstleistungen wird von Energieversorgern oder auch anderen branchenfremden Unternehmen derzeit jedoch nur wenig erkannt.

Das Engagement von Umsetzungspartnern bleibt somit eine der wichtigsten Herausforderungen bei der Umsetzung im Quartier. So sind Unternehmen, die beispielsweise in Wärmenetze investieren könnten, nicht bereit das Investitionsrisiko zu tragen und haben wegen mangelnder Anreize und Verdienstmöglichkeiten kein Interesse im Quartier aktiv zu werden. Unter Anbetracht relativ niedriger Preise fossiler Energieträger bleibt die Wirtschaftlichkeit eine weitere Herausforderung, denn teure Maßnahmen mit höherer Energieeffizienz lohnen sich so oft nicht. Außerdem können die



im Quartier ansässigen Akteure (Wohnungsbaugenossenschaften, Einzeleigentümer etc.) die Maßnahmen hinauszögern oder Maßnahmen wegen eines zu niedrigen Alters (noch zu wenig Einkommen, um in energetische Sanierungen zu investieren) oder zu hohen Alters (keine Investitionsbereitschaft mehr) nicht umsetzen.



**Abbildung 3. Erfolgsfaktoren und Herausforderungen bei der Umsetzung**

Förderlich ist für die Umsetzung dagegen die transparente und attraktive Akteursansprache. Mit Ehrlichkeit, Motivation und regelmäßiger Ansprache in lockerer Atmosphäre wirkt die Umsetzungsabsicht vertrauenswürdig und glaubwürdig, was die eigentliche Verankerung der urbanen Innovationen steigert. Sofern diese durch zentrale bekannte Akteure wie Energieversorger, die bereits eine starke Kundenbindung haben, und Multiplikatoren wie eine Investitionsbank oder die lokale Presse unterstützt wird, erhöht sich die Umsetzungswahrscheinlichkeit ebenfalls. Anreizsysteme befördern die Umsetzung zusätzlich: Ob dies Anreize mit Signalwirkung (zum Beispiel eine Klima-Plakette) oder finanzieller Natur (durch zum Beispiel Rendite in Genossenschaftsgründungen) sind, ist dabei nebensächlich, sofern sie auf verlässlichen Voruntersuchungen beruhen und den Klimavorteil klar aufzeigen.

### **Fazit**

Die in Quartierskonzepten erarbeiteten urbanen Innovationen sind bisher im Mittel wenig innovativ, obwohl das inhaltlich breit angelegte Förderprogramm Potenziale für einen integrierten Ansatz zur zukunftsfähigen Gestaltung von Stadtvierteln bietet. Für die Bewertung des Innovationsgrades ist die Betrachtung der technologischen Neuartigkeit allein nicht ausreichend. Innovativ ist ein Konzept dann, wenn für den Quartierskontext heterogene und einzigartige Lösungen geschaffen werden, die über neuartige

Kommunikationswege unterstützt werden und über die Standards des Fördergebers hinausgehen.

Ein systematisch-strukturiertes Management kann die Umsetzung von Quartierslösungen unabhängig von deren Innovativität und Komplexität unterstützen. Damit ist ein hoher Innovationsgrad auch nicht als Umsetzungshemmnis, sondern als Chance für die Zukunftsfähigkeit des städtischen Raums anzusehen. Die Verankerung neuer Energiedienstleistungen wie Carsharing, Contracting oder Mieterstrommodellen im Quartier unterstützen diese Zukunftsfähigkeit und helfen, Akzeptanzbarrieren zu überwinden. Zusätzlich könnte der städtische Raum über weitere digitale Dienstleistungen, die auf aus intelligenten Messsystemen gewonnenen Daten basieren, an Innovativität und Zukunftsfähigkeit gewinnen.

#### *Über die Studie*

Das Institut für Innovationsforschung an der Christian-Albrechts-Universität zu Kiel untersuchte energetische Quartierssanierungen in drei Teilstudien:

*Qualitative Befragung:* 14 semi-strukturierte Interviews mit Auftraggebern, Konzepterstellern und Umsetzungsmanagement zur Identifikation von Erfolgsfaktoren und Barrieren in energetischen Quartierssanierungen

*Quantitative Befragung:* Empirische Befragung von 127 Auftraggebern und Konzepterstellern in 101 energetischen Quartierssanierungen in Deutschland zur Aufdeckung von Erfolgswahrscheinlichkeiten in der Konzepterstellung (z.B. Stakeholder-Integration und Projektmanagementkompetenz)

*Qualitativ-quantitative Analyse:* Auf Text Mining basierende Analyse von 168 Quartierskonzepten in Deutschland zur Bewertung der Innovativität der Konzepte und Erarbeitung der in Quartierssanierungen erarbeiteten Maßnahmen

**Erklärung zum selbständigen Verfassen der Arbeit**

Ich erkläre hiermit, dass ich meine Doktorarbeit „*Stakeholder management in complex innovation processes*“ selbstständig und ohne fremde Hilfe angefertigt habe und dass ich als Koautor maßgeblich zu den weiteren Fachartikeln beigetragen habe (s. 7. Note on co-authorship). Alle von anderen Autoren wörtlich übernommenen Stellen, wie auch die sich an die Gedanken anderer Autoren eng anlehrenden Ausführungen der aufgeführten Beiträge wurden besonders gekennzeichnet und die Quellen nach den mir angegebenen Richtlinien zitiert.

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