Landscape and Urban Planning 151 (2016) 45–54

Contents lists available at ScienceDirect

Landscape and Urban Planning

journal homepage: www.elsevier.com/locate/landurbplan

Application and evaluation of a participatory "open innovation" approach (ROIR): The case of introducing zero-acreage farming in Berlin

Kathrin Specht[a,*], Felix Zoll[b], Rosemarie Siebert[a]

[a] Leibniz Centre for Agricultural Landscape Research, Institute of Socio-Economics, Eberswalder Straße 84, 15374 Müncheberg, Germany
[b] Humboldt University of Berlin and Leibniz Centre for Agricultural Landscape Research, Institute of Socio-Economics, Eberswalder Straße 84, 15374 Müncheberg, Germany

HIGHLIGHTS

- This first evaluation of the ROIR validated its potential as a planning tool.
- Major benefits of ROIR lie in encouraging cooperation and knowledge generation.
- Prospectively, ROIR can improve experts incorporation into innovation development.

ARTICLE INFO

Article history:
Received 22 July 2015
Received in revised form 2 March 2016
Accepted 4 March 2016
Available online 2 April 2016

Keywords:
Technology roadmapping
Innovation process
Stakeholder
Network
Urban agriculture
Knowledge
Rooftop farming

ABSTRACT

This paper reports on the application and evaluation of a participatory approach called Regional Open Innovation Roadmapping (ROIR), which brings together different stakeholders to jointly develop strategies for the implementation of regional innovations. More specifically, ROIR is a tool to promote sustainable regional development that integrates "open innovation" elements in technology roadmapping. We applied this approach to the introduction of the innovative building-related urban agriculture subtype known as "Zero-acreage farming" (ZFarming) to the Berlin metropolitan area. ZFarming includes rooftop gardens, rooftop greenhouses, edible green walls, indoor farms and/or vertical greenhouses. Thus, the ROIR approach was applied between 2011 and 2013 to define sustainable development options for ZFarming in Berlin, specifically aiming both to find possible ZFarming models for Berlin and to develop guidelines for their sustainable implementation. During the participatory process, approximately 50 contributors established a stakeholder network and jointly defined a roadmap to enable administrators, politicians, citizens and practitioners to effectively address ZFarming. An ex-post evaluation was conducted in 2014 via an online survey to estimate the effects of the ROIR approach on (a) knowledge generation, (b) new stakeholder network establishment, (c) new project implementation and (d) the general perception of ZFarming. The results revealed that the ROIR process stimulated the establishment of new networks and alliances, contributed to knowledge generation and created a common understanding for the future implementation of ZFarming among diverse stakeholders.

1. Introduction

In general, participatory planning approaches are acknowledged as an effective means of helping cities address both current and expected future problems. Involving stakeholders in planning processes is understood as a way to incorporate local actors' knowledge and values and can serve as the basis for the implementation and acceptance of solutions (Luz, 2000; Murgue, Therond, & Leenhardt, 2015).

In the context of innovation development, the participation and inclusion of local stakeholders has mostly been neglected. Classical innovation models have largely followed the hypothesis that innovations are developed by scientists, disseminated through extension and education and then implemented into practice (the

* Corresponding author.
E-mail addresses: specht@zalf.de (K. Specht), FelixZoll@gmx.de (F. Zoll), rsiebert@zalf.de (R. Siebert).

http://dx.doi.org/10.1016/j.landurbplan.2016.03.003
0169-2046/

"linear innovation model") (Leeuwis, 2004). In those models, therefore, innovation is mainly embodied in technological artifacts and its successful implementation is related to users' capacity to learn to "adopt" these artifacts in practice (OECD, 2005; Rogers, 2003). Today, this view has been challenged by many, and alternative approaches increasingly define innovation as a process that includes a panoply of actors and focuses more on individual and collective learning processes than on the adoption of technological artifacts (Beers and Veldkamp, 2011; Kemp, Schot, & Hoogma, 1998; Knickel, Brunori, Rand, & Proost, 2009). In recent years, it has generally been acknowledged that collaboration among various actors is essential for the successful development of new ideas in the field of sustainable development (von Malmborg, 2007). Particularly in the area of innovation development, the integration of relevant regional stakeholders has become more central (Schwerdtner, Siebert, Busse, & Freisinger, 2015). Scholars stress the relevance of knowledge networks and information flows and the importance of learning and social interaction to innovation (Seyfang & Smith, 2007).

In this new, systemic understanding, innovation is an outcome of processes within collaborative networks in which information is exchanged and learning processes occur. Building on this systemic view and in search of practical solutions to better integrated knowledge into the innovation process, the "Regional Open Innovation Roadmap" (ROIR) has been developed by Schwerdtner et al. (2015). Following Schwerdtner et al. (2015), ROIR "is designed to utilize the innovation potentials of a region for its sustainable development and to maximize the prospect of innovation success".

The basic principle of ROIR approach is rooted in the idea of "open innovation." Open innovation can be defined as "the use of purpose inflows and outflows of knowledge to accelerate innovation" (Chesbrough, 2011) and includes not only opening up to receive external knowledge in the initial stages of an innovation process but also the continued participation of internal and external stakeholders in all stages of the process (Schwerdtner et al., 2015). According to proponents of "open innovation," integrating various actors into the development of an innovation can improve the innovation's potential (Bartl, 2008; Chesbrough, 2011; Gassmann, Enkel, & Chesbrough, 2010).

The ROIR approach was applied to the introduction of the "Zero-acreage farming" (ZFarming) innovation to the city of Berlin. ZFarming is a visionary subtype of urban agriculture (UA). It includes all types of food production characterized by the nonuse of farmland or open space. Types of ZFarming include rooftop gardens, rooftop greenhouses (RTGs), edible green walls and innovative forms such as indoor farms or vertical greenhouses (Specht & Siebert, 2014; Thomaier et al., 2015).

This paper presents the application and evaluation of the ROIR approach. It aims both to provide insights about the application of the ROIR approach and to analyze the approach's effects on and contribution to the implementation of the ZFarming innovation. Although the ROIR has previously been applied, its impacts have not been evaluated. This is the first study to systematically analyze the effects of the participatory ROIR approach.

The specific objectives of this paper are as follows:

- To present how the ROIR approach was applied in the case of introducing the ZFarming innovation in Berlin;
- To analyze the extent to which the "open innovation" process contributed to increasing the innovation's potential in terms of (i) knowledge generation, (ii) establishing stakeholder networks, (iii) implementing new projects, and (iv) the general perception towards the innovation; and
- To discuss the suitability of the applied approach as a planning tool, its potentials and limitations and prospects for the future development of ZFarming.

2. The "Zero-acreage farming" (ZFarming) innovation: State of knowledge and implementation

The ZFarming innovation is situated in the large innovation field of UA, a new area of scholarly debate that generally demonstrates a high potential for innovation development and novelty creation (Berges et al., 2014; van Schans, Renting, & van Veenhuizen, 2014). In addition to food production, UA can potentially contribute to green a city, reduce the carbon footprint, stimulate the productive use of organic waste and increase consumer awareness (Bohn & Viljoen, 2010; Eigenbrod & Gruda, 2015; Gorgolewski, Komisar, & Nasr, 2011; Pourias et al., 2015; McClintock, 2010; McClintock, Mahmoudi, Simpson, & Santos, 2016; De Zeeuw, Van Veenhuizen, & Dubbeling, 2011). Activities can range from family food gardens to community-based farming and commercial flagship projects employing high-tech production processes (Mok et al., 2014; Opitz, Berges, Piorr, & Krikser, 2015; Orsini, Kahane, Nono-Womdim, & Gianquinto, 2013).

The UA's visionary subtype of "Zero-acreage farming" (ZFarming) has recently gained increasing attention. Most such projects are located in large cities in North America and Asia (Thomaier et al., 2015). The major potential benefits of ZFarming involve opportunities to link food production with urban buildings and to exploit possible synergies deriving from that combination. The basic idea is to establish small-scale resource-saving systems whereby food production and consumption can be spatially and temporarily reconnected, potentially leading to energy savings in heating, transporting, cooling, packaging and waste disposal (Sanyé-Mengual, 2015). Examples of the direct use of urban waste resources include the reuse of rainwater or wastewater for irrigation purposes, the use of waste heat from local sources (such as buildings, swimming pools or bakeries) to heat a RTG or the reuse of locally accumulated organic waste as plant nutrients (Grard et al., 2015; Nelkin & Caplow, 2008; Sanyé-Mengual, 2015). ZFarming deserves special attention as a strategy for either very dense cities with limited space for ground-based agriculture or large cities that are not surrounded by sufficient agricultural land to establish regional food systems (Specht et al., 2014).

To date, there have been only a few studies of ZFarming. The previous literature covers various technical aspects of rooftop gardens, RTGs and vertical farming, addressing, for example, the process of creating ZFarming projects and entrepreneurial concepts (Engelhard, 2010; Nelkin & Caplow, 2008; Wilson, 2002). Such studies describe practical experiences or solutions to solve existing problems, aiming to stimulate innovation or replicate successful projects in other parts of the world. The new concepts are described with respect to their functionality, whereas questions regarding the introduction process are addressed only secondarily.

A second group of studies addresses the social, environmental and economic potential and limitations of innovative UA forms, including rooftop gardens, RTGs and/or vertical farming (Astee & Kishnani, 2010; Besthorn, 2013; Caplow, 2009; Cerón-Palma, Sanyé-Mengual, Oliver-Solà, Montero, & Rieradevall, 2012; Despommier, 2010; Germer et al., 2011; Sanyé-Mengual, Cerón-Palma, Oliver-Solà, Montero, & Rieradevall, 2013, Sanyé-Mengual, Cerón-Palma, Oliver-Solà, Montero, & Rieradevall, 2015, Sanyé-Mengual, Oliver-Solà, Montero, & Rieradevall, 2015, Sanyé-Mengual, Anguelovski, Oliver-Solà, Montero, & Rieradevall, 2016; Specht et al., 2014; Specht, Siebert, & Thomaier, 2015, Specht, Siebert et al., 2015; Thomaier et al., 2015). In these articles, innovations are addressed as a complex subject that includes technological, organizational and societal aspects. Nonetheless, the innovation process itself is only addressed as a side point. Particularly for European cities, the development of ZFarming and the corresponding research has only recently begun.

In summary, the innovation of ZFarming is generally at a very early stage of research and development. There are open questions that range from uncertainties about economic viability to technological questions to questions about social acceptance, thus making the topic a highly promising object for exploration through the ROIR approach. Moreover, the innovation of ZFarming has never been investigated with a focus on the innovation process itself from a social-science perspective.

3. Application of the "Regional open innovation roadmapping" (ROIR) approach

We chose Berlin, the capital of Germany, to investigate the potential for the introduction of ZFarming to an urban area. Among Europe's cities, Berlin stands at the forefront of developing innovations in the field of UA. As Specht, Weith, Swoboda, and Siebert (2016) elaborate, the city can build upon a long history of urban farming with more than 3000 ha of traditional allotment gardens (Senate Department for Urban Development and the Environment Berlin, 2015). Additionally, and mostly developed in recent years, Berlin has more than 100 inner-city community gardens along with commercial urban farming enterprises that develop prototypes and technologies for ZFarming and large-scale urban food production (e.g., "ECF- Efficient City Farming," "topfarmers," and "watergy"). We find increasing consumer demand for local food (BMELV, 2013), along with growing political acknowledgement of and media attention to innovative approaches in the field of UA. Taking these frame conditions into account, Berlin appears to be a promising site for innovation development in the field of ZFarming.

The participatory "open innovation" approach – which has been defined as the ROIR approach (Schwerdtner, Freisinger, Siebert, & Werner, 2010; Schwerdtner et al., 2015) – was applied to the ZFarming innovation between 2011 and 2013. The ROIR process was one cornerstone of the research project "ZFarm-Urban agriculture of the future." The goals of the project and the ROIR process were to find possible farming models in or on urban buildings in the Berlin metropolitan area and to identify the options available for their sustainable implementation (see Specht & Siebert, 2014; Specht, Siebert et al., 2015). The final evaluation of the ROIR process and analysis of the evaluation results was conducted in 2014.

The ROIR approach is an instrument for participatory decision-making in the implementation of innovations. It depicts in advance the entire development, implementation and launch of a project in detail and includes the expertise and opinions of all relevant stakeholders from the outset (Phaal, Farrukh, & Probert, 2004; Schwerdtner et al., 2015). Based on the elaborations of Schwerdtner et al. (2015), the ROIR approach is characterized by the integration of elements from "Technology Roadmapping" (TRM) to "open innovation". ROIR benefits from cooperating with various stakeholders. The approach includes all stakeholder groups that might be of relevance at any stage of the innovation procedure from initial development to market introduction. In our case, the ROIR process was divided into four main phases as previously proposed and described by Schwerdtner et al. (2015) and Specht, Siebert et al. (2015) (see Fig. 1).

Phase I—Selection of relevant experts: The ROIR process began with the identification of relevant stakeholders. Various experts relevant to ZFarming were approached and invited to partake in the ROIR process. In this first phase, 38 stakeholders were interviewed to identify the relevant key issues for further exploration (Specht, Siebert et al., 2015). These stakeholders included practitioners, planners, researchers, representatives of policy and administrative bodies, lobby groups and experts on sales and distribution. Some of the stakeholders were already actively involved in UA and ZFarming activities, whereas for others, the topic was entirely new.

Phase II—Selection of the specific innovation: The selected stakeholders met in a series of workshops between 2011 and 2013 in Berlin. In the beginning, the stakeholders considered and discussed the possibilities and limitations of various types of ZFarming, including rooftop gardens, RTGs, vertical fruit and vegetable gardens, and multistory indoor farms. Based on a broad analysis of the expected economic, ecological and sociocultural impacts of the different proposals, it was jointly decided that RTGs seemed to have the most development potential for Berlin. In this second phase, the participants chose RTGs as innovation to be further developed. RTGs were a highly suitable innovation object to be examined within the ROIR process because they are in an early stage of development and therefore confront a range of open questions and limitations for implementation (ranging from planning issues over unsolved legal and technological questions to risks related to societal rejection). Those barriers are manifold and need to be overcome before a wider market implementation will be possible.

Phase III—Development of the innovation concept: In the workshops of phase III, RTGs were examined in detail. Attention was paid to the technical, social, economic, environmental, administrative and political framework conditions. The stakeholders addressed the various types of RTGs, along with their various aims and orientations. Thus, RTGs were discussed as they pertain to the following possibilities: (1) commercial agricultural production; (2) urban quality of life (e.g., RTGs as green spaces on residential buildings); (3) social and educational purposes (e.g., RTGs as school gardens); (4) RTGs as innovation drivers (e.g., RTGs in research institutions); and (5) Image-oriented projects (e.g., RTGs on top of restaurants) (compare Freisinger et al., 2015; Thomaier et al., 2015). The ROIR participants collected and discussed the necessary conditions to ensure a successful implementation of ZFarming – considering their diverging aims and purposes – and how these conditions can be established (Specht, Siebert et al., 2015).

Phase IV—Roadmap for implementing ZFarming: During the last phase of the ROIR workshops, a stakeholder network called "ZFarm—Urban agriculture of the future" was established. This network (of approximately 50 participants) jointly created a practical guide to enable practitioners, future operators, politicians, researchers, and citizens to address the issue of RTGs in Berlin (see Freisinger et al., 2015). The manual covers all steps involved in the planning and implementation process, from the initial idea to the finished RTG.

4. Ex-post evaluation of the ROIR approach

4.1. Investigation method: online survey

To evaluate the impact of the ROIR process, we conducted a complete online survey of the entire group of participants following the end of the participatory process in 2014. Because the objective was to explore the effects of the participatory process, the survey was divided into five topical sections:

Part I: Knowledge generation and exchange
Part II: Establishing new stakeholder networks and cooperation
Part III: Implementation of new projects
Part IV: Effects on the general perception of ZFarming
Part V: Final evaluation of the ROIR effects

Furthermore, the survey included a section on the participants' characteristics and sections for further remarks. In our survey, we employed questions to be answered and statements to be evaluated. Most were based on a five-point scale (from 1 = fully agree, to 5 = fully disagree) along with an "I do not know" option. Furthermore, multiple-choice questions were offered along with a free answer option if none of the offered response options was appropriate. Finally, there were questions for which only one answer

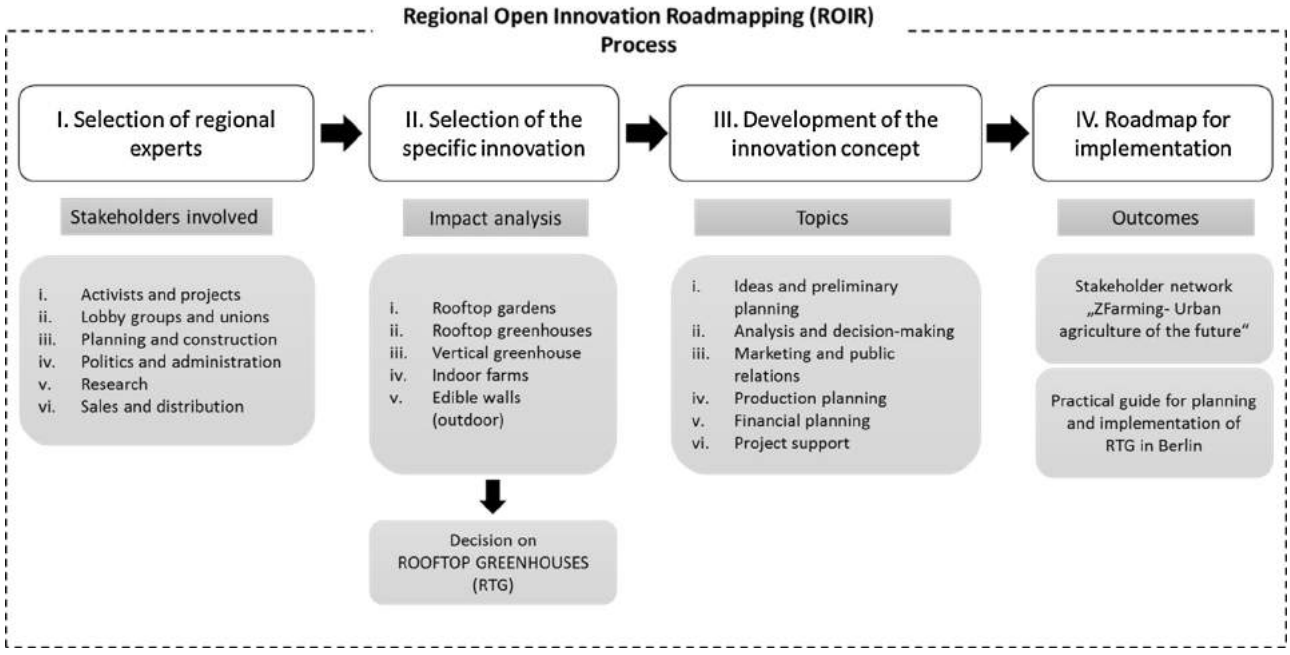

Fig. 1. Overview of the four main phases of the ROIR approach for the introduction of the "ZFarming" innovation (adapted from Schwerdtner et al. (2015) and Specht, Siebert et al., 2015).

could be selected, and diverging answers were captured in a free text field. Prior to the launch, three ROIR participants pre-tested the survey for comprehensibility and consistency. QuestBack EFS Survey 10.3 software (QuestBack GmbH, Cologne, Germany/QuestBack AS, Oslo, Norway) was used to implement the online survey. Eight people repeatedly tested the survey's technical functionality.

4.2. The empirical basis of the survey

On March 4, 2014, personalized survey invitations were sent via e-mail to the 58 stakeholders who participated in the ROIR process. The e-mail contained a description of the research, along with a direct link to the survey. The participants were also offered the option of filling out the survey on paper. Two reminders were sent out (March 19 and April 1, 2014). The evaluation process ended on April 8, 2014. During that period, 31 persons completed the survey, corresponding to a response rate of 53%.

The sample size might appear small for conducting quantitative analysis. However, the small size is justified because the 58 requested stakeholders represent the total possible sample size, and the character of our study is rather explorative. As Kutter, Tiemann, Siebert, and Fountas (2009) describe, the quantification can help to further illustrate and underpin the qualitative findings where meaningful and appropriate.

Table 1 presents an overview of the participants' gender, age group and level of proficiency (measured by years of experience in their respective fields of work). When participants were asked to define their field of work, the questionnaire allowed for multiple answers. As the pre-test revealed, several participants represented various stakeholder groups in the workshops (such as a company and a lobby group).

5. Results

Below, we present the results of the online survey of the participants in the ROIR process for ZFarming in Berlin. The results are displayed along four subsections to present the extent to which the "open innovation" process contributed to increasing the potential for ZFarming in terms of (1) knowledge generation, (2) establishing stakeholder networks, (3) implementing new projects and (4) the general perception of ZFarming.

5.1. Contribution of the ROIR process to knowledge generation

The ROIR process was intended as a platform for knowledge exchange and generation, which was perceived as a key challenge. During the ROIR workshops, stakeholders from various disciplines and backgrounds were brought together. For some, it was the first time that they had worked with members of the other stakeholder groups and thus were able to exchange insights into other stakeholders' perspectives and demands. Furthermore, the topics covered in the participatory workshops involved many disciplinary fields. The thematic sessions ranged from technical issues related to ZFarming to social, financial, political, legal and other topics. Prior to each workshop, the participant with the most expertise in the respective field was selected and asked to prepare a short introduction to the topic. At the beginning of each session, the expert provided a brief "state of the art" on the topic to begin the discussion and ensure that participants from other fields could follow and contribute to the debate. Moreover, stakeholders continued their knowledge exchange alongside the ROIR meetings.

To evaluate the overall effect on knowledge generation, we compared stakeholders' knowledge regarding ZFarming before and after the ROIR workshops (Table 2). The survey revealed an increase in all categories; the participants experienced gains in terms of increased knowledge of the topic, meeting other ZFarm actors and gaining a practical perspective on ZFarming. Notably, all ten people who had no prior contact with ZFarming before participating in the workshops assigned themselves to higher proficiency levels afterwards, thus indicating an increase in knowledge.

Overall, by participating in the ZFarm project, the stakeholders became more engaged with ZFarming, both in terms of knowledge dissemination and practical reference.

As a result of the evaluation, most of the stakeholders indicated that the experts' input presentations were relevant to the

Table 1
Empirical basis for process evaluation (online survey).

Main category	Category [answer]	Frequency of answers; n = 31 [single response category]
Sex [male/female]	male	19
	female	12
Age group of participants [years]	< 21	0
	21–30	3
	31–40	3
	41–50	6
	51–60	12
	> 60	7
Professional working experience [years]	< 2	3
	2–5	4
	6–10	3
	11–20	6
	> 20	15
		n = 31 [multiple response category]
Stakeholder groups [field of work]	Research	14
	Policy and administration	8
	Planning and construction	8
	Lobby groups and unions	6
	Sales and distribution	4
	Project groups/activists	4
	Others	2

Table 2
Comparing ZFarming knowledge before and after the workshops.

Category [Question]	Category [Answers]	Frequency [single response category]; n = 31
To what extend were you familiar with the topic of building-integrated agriculture before the workshops started?	Not at all.	10
	I already had insight into the topic and knew other stakeholders.	12
	I had already been involved in the practical side of the topic.	6
	I already knew stakeholders and the structures of building- integrated agriculture, and actively helped shape them.	3
To what extend were you familiar with the topic of building-integrated agriculture *after the workshops ended*?	Not at all.	0
	I have insight into the topic and know other stakeholders.	16
	I am involved in the practical side of the topic.	10
	I know stakeholders and the structures of building- integrated agriculture, and actively help shape them.	5

innovation process (n = 21) and helped them develop a better understanding of the topic (n = 24).

Interdisciplinary elements are important to the ROIR approach. Thus, the workshops were further assessed with respect to interdisciplinary knowledge generation and sharing. The majority of respondents (n = 22) agreed with the following statement: "By participating in the workshops, I've gained access to knowledge from other specialist fields". This growth in knowledge and understanding was evaluated by the participants both as a general benefit and as value-adding (n = 18).

In summary, the results demonstrate that participation in the ROIR workshops contributed to increase stakeholders' knowledge about ZFarming.

5.2. Establishing new networks and cooperation through the ROIR process

Establishing new collaborations and networks among the participants is considered both a keystone and a major aim of the ROIR approach. In theory, the process aims at fostering interdisciplinary networking. By bringing stakeholders from various fields together to focus on one area – in this case, ZFarming – the basis for facilitating interdisciplinary networking was established. Our analysis revealed that the ROIR process indeed facilitated the establishment of new cooperation and inter- and transdisciplinary networks.

Table 3 summarizes the results of Part II of the questionnaire (Networks). First, the stakeholders were asked if they could establish contact with other stakeholder groups following the workshop (including their own—from administrators to activists, from lobby groups to researchers, etc.) and if so, how many (Table 3, Q1), with the aim of estimating the workshop's effect on networking. Second, the participants were asked if they could establish contact with stakeholder groups with whom they had not been connected, and if yes, to how many (Table 3, Q2).

The participants qualified their networking by naming the groups with whom they established contacts and then characterizing these new contacts (see Table 4).

The survey revealed that the ROIR process fostered the establishment of new networks among participating stakeholders. As Table 3 shows, participants were able to connect to other stakeholder groups. Almost half of the participants (n = 15) could even connect to stakeholder groups with whom they had never before cooperated (Table 3, Q2). Table 4 also shows that although the main mode of new contacts is "informal communication," the establishment of joint projects, regular formal exchanges and resource exchanges were also reported by the participants.

5.3. Implementation of new projects in the innovation field

The following section addresses the question of whether collaborative work, networking and general engagement with the topic of ZFarming triggered the practical implementation of ZFarming projects. Approximately half of the surveyed persons indicated that they have been involved in a ZFarming project since their ROIR participation (n = 14). The fact that almost half of the interviewees are involved in a real ZFarming project is positive. However, this result is more of a clue than direct evidence that there is a connection between their ROIR participation and the initiation of a practical project. The connection becomes more obvious when

Table 3
Results of the survey (part 2) identifying the effects of the ROIR process on establishing new networks among the participants.

Category [Question]	Category [Answers]	Frequency [single response category]; n = 31
[Q1] How many contacts with other stakeholder groups (including your own) could you establish through ROIR participation?	No additional contacts established	5
	Contacts could be established with members of: *one* other stakeholder group	4
	two other stakeholder groups	7
	three other stakeholder groups	6
	four other stakeholder groups	3
	five other stakeholder groups	3
	six other stakeholder groups	3
[Q2] How many contacts with *entirely new* stakeholder groups (other than your own) could you establish through ROIR participation?	No contacts could be established with members of entirely new stakeholder groups	16
	Contacts could be established. . . with *one* entirely new stakeholder group	7
	with *two* entirely new stakeholder groups	2
	with *three* entirely new stakeholder groups	1
	with *four* entirely new stakeholder groups	3
	with *five* entirely new stakeholder groups	2

Table 4
Overview of the type of networking that could be established among the stakeholder groups through the ROIR approach.

Category [Q2]: What kind of contacts do you have to participants from other specialist fields? Category [Q1]: With which stakeholder group could you establish new contact?	Informal communication	Exchange of knowledge at regular meetings or discussions	Sharing of resources (services, infrastructure etc.)	Establishment of joint projects	Sum
Research	17	11	5	13	46
Policy/administration	16	5	3	5	29
Planning/construction	10	8	5	7	30
Lobby groups/unions	17	4	3	6	30
Sales/distribution	9	2	3	3	17
Project groups/activists	16	3	1	5	25
Sum	85	33	20	39	

the results from Table 2 are considered because they allow for a before/after comparison with respect to the participants' involvement in ZFarming. A nearly 20% increase in the number of people practically engaged in the topic and actively creating structures in ZFarming could be found.

The realized projects were set up in different fields. Most of the single-purpose projects were related to research (eight new projects), which might be attributable to the fact that ZFarming is a relatively new area of study and a great deal of research remains to be conducted. Another reason might be that a large portion of those surveyed work in research (see Table 1). One project is a pure social project. Two others are entrepreneurial business ventures. Three of the projects were established as intersecting projects (social + research; entrepreneurship + education; research + education). These findings show that ZFarming can be flexibly implemented and can emphasize the interdisciplinary aspects of its practical application.

To identify possible barriers and challenges to ZFarming, we also asked what prevented the realization of further projects. The majority of those who were not involved in a ZFarming project after the ROIR process did not see any demand for ZFarming in their enterprise or organization (n = 12): this was the largest obstacle to ZFarming. According to the respondents' answers, high costs were the second most significant barrier to the realization of a ZFarming-project (n = 4), followed by a lack of staff resources (n = 3), bureaucratic obstacles (n = 2), lack of interest (n = 2), lack of expertise (n = 2) and technical feasibility (n = 2). One respondent indicated that ZFarming did not have sufficient acceptance among the target groups. It is remarkable that none of the interviewees identified a lack of future prospects and marketing opportunities as a barrier. Although the experts primarily indicated that a lack of demand hindered them from realizing a ZFarming project, they still seemed to believe in the future opportunities and potential of ZFarming (compare Section 5.4).

Overall, the results in this section showed that almost half of the respondents were involved in a practical ZFarming project after the end of the ROIR workshops. These projects were established in various fields with multiple objectives. Even those not involved in ZFarming projects did not question the prospects and marketability of ZFarming (compare Section 5.4).

5.4. Effects on the general perception of the innovation

Below, we describe how participation in the ROIR process affected stakeholders' acceptance and the general perception of ZFarming. In this context, it is important to consider that ZFarming is a new field.

Generally, in the early innovation phase, people tend to assess innovations with skepticism and reject instead of accept them because the majority typically fail to recognize the innovative potential of new ideas (compare Section 1). Nonetheless, our results show that the majority of participants began the ROIR process with a generally positive attitude toward the issue of ZFarming (Table 5, Q1). More than half of the participants stated that they were open-minded and harbored no negative prejudice toward ZFarming. To explain this fact, it is important to note that the participants voluntarily joined the ROIR process. People with a basic attitude of rejection toward ZFarming were relatively unlikely to join the group.

The results reveal that in most of the cases, the general attitude toward ZFarming has either improved or remained the same (Table 5, Q2). The opinion became more negative after the process for only a small group (6). The specific reasons for these opinion changes were not provided in the survey responses.

The participants were also asked about their general perception of ZFarming and how they evaluate the potential for its future development. The majority indicated that they perceive ZFarming to have promising elements that can be further developed and can potentially contribute to sustainable urban development, to building a viable business or to connecting with an existing business to improve the image of a company or enterprise (see Fig. 2).

Table 5
Changes in participants' attitudes and opinions toward ZFarming through the ROIR process.

Category [Question]	Category [Answers]	Frequency [single response category]; n = 31
[Q1] What was your attitude/opinion toward ZFarming before the series of the ROIR workshops started?	Positively open minded	16
	Positive-neutral	6
	Neutral	6
	Neutral-critical	1
	Critical	2
[Q2] How has your attitude/opinion toward ZFarming changed through the ROIR process?	My opinion was more positive afterwards	11
	My opinion has not changed	14
	My opinion was more critical afterwards	6

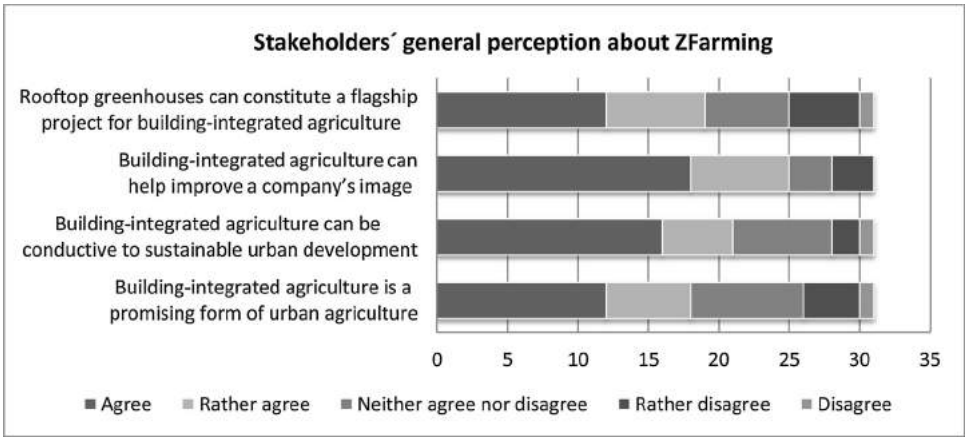

Fig. 2. Stakeholders' general perceptions of ZFarming after the ROIR process.

Table 6
Overview of the final evaluation of aspects that were particularly appreciated by participants in the ROIR process.

Category [Question]	Category [Answers]	Frequency [multiple response category]; n = 31
[Q1] Which aspects of the series of workshops did you consider to be particularly positive?	Networking with stakeholders from other specialist fields	25
	Interdisciplinary thinking	21
	Sharing of interdisciplinary knowledge	21
	Having gained an overview of the topic of building-integrated agriculture	20
	The working atmosphere during the workshops	17
	Having gained food for thought for my profession practice	12
	Being involved in the evolution of an innovation	11
	The joint development of the guide	9
	Having created something that could be of use to Berlin	8

The participants claimed that RTGs in particular can constitute a flagship project for building-integrated agriculture (n = 19). Moreover, the majority of the participants (n = 18) agreed that ZFarming represents a promising concept in UA (see Fig. 2).

5.5. Consistency of the ROIR aims with process outcomes

According to its methodological background, one of the primary aims of the ROIR approach is to provide a framework for communication by allowing regional actors and stakeholders who rarely meet to come together to recognize one another's demands and find ways for better cooperation (as described by Schwerdtner et al., 2015). In this way, the ROIR process becomes a communication platform for knowledge exchange. Table 6 shows that the majority of stakeholders greatly appreciated the approach, mainly because of these aspects. According to our results, the large majority of stakeholders (n = 25) indicated that the ROIR approach is a viable method of actively shape society.

When analyzing which elements of the ROIR process the participants found particularly valuable, we found consistency with the previously targeted process aims. Stakeholders appreciated the opportunity to establish new networks, the interdisciplinary knowledge exchange and the practical work aimed at further developing the specific innovation (Table 6).

6. Discussion

In this paper, we have provided insight into the ROIR approach, drawing on experiences, answers and opinions from relevant stakeholders in the field of ZFarming in Berlin.

First, we want to highlight the general *potential of the ROIR approach for the participatory development of regional innovations* demonstrated by our research findings. Systemically, innovation is an outcome of processes within collaborative networks in which information is exchanged and learning processes occur. Scholars stress that information flows within networks, joint learning and social interaction are relevant to innovation (Knickel et al., 2009; Seyfang & Smith, 2007). As Schwerdtner et al. (2015) describe, the ROIR approach provides a framework for communication by allowing regional stakeholders who might otherwise meet only rarely to gather together to meet one another and find ways to cooperate. Our results show that the inclusion of regional stakeholders in the planning and innovation process through the ROIR approach largely resulted in the desired effects. As previously observed and hypothesized by Schwerdtner et al. (2015), our results can confirm that the ROIR process stimulated the parties to establish new networks and alliances, contributed to knowledge generation and created a common understanding for the future implementation of the innovation (here ZFarming) among stakeholders. Moreover,

the approach was highly valued by the participating stakeholders because it allowed them to reflect upon and decide about different development options.

Second, we want to reflect on ROIR's contribution to the *further development of the innovation of ZFarming*. From our results, we can confirm that the idea of "open innovation" can improve innovation potential by integrating different actors into the development of the innovation, as proposed by Bartl (2008), Chesbrough (2011) and Gassmann et al. (2010). As concrete outcomes of the ROIR process in our case, the various stakeholders were able to establish a network for the further development of ZFarming. They also developed a practical guide that addresses the planning and implementation of RTGs in Berlin (Freisinger et al., 2015), which includes the knowledge, concerns and perspectives of all of the relevant stakeholders, from practitioners to policy makers. These outcomes will foster the further development of ZFarming in Berlin and beyond. Further steps can build upon these existing networks and guidelines for future implementation. Hereafter, to further develop the innovation of ZFarming, stakeholders can deepen their cooperation and further extend their networks. They can establish joint pilot projects to generate greater public awareness and continue working on the institutional integration of UA practices into local planning strategies.

Despite the positive effects that were previously observed (Schwerdtner et al., 2015) and have now been confirmed by our survey results, we would like to reflect upon several challenges and limitations experienced during the various ROIR phases.

In the starting phase, one of the major challenges was caused by the *openness of the process outcomes*. At the beginning of the process flow, several solutions were explored simultaneously. Only at a later stage were the options jointly narrowed to choose which ZFarming innovation and topics would be explored and addressed. At the very beginning, this openness (which is a key element of the ROIR approach) created some doubts and uncertainty among the stakeholders about the outcome. Some stakeholders even questioned whether the process would have any concrete results at all. This happened because the majority of stakeholders are accustomed to participating in processes in which the expected outcome of the process is more or less outlined from the very beginning; such stakeholders are usually invited to contribute their expertise to a clearly defined objective. This required a high level of moderation effort at the beginning to convince the stakeholders to open up for this "joint learning" approach.

The fact that the specific innovation cannot clearly be named at the beginning of the workshops creates another risk. Participants might drop out in phase II if the specific innovation that they desired is not selected. In our case, however, even participants who wanted to work on a different innovation (e.g., indoor farming) remained in the group because they saw enough topical overlaps with RTGs that they felt they could still contribute to and benefit from the ROIR workshops.

During the main ROIR phases, one of the most challenging issues related to defining our *role as researchers* in the process by finding ourselves in the roles of process facilitators. Being in charge of conducting and managing the ROIR process, our main tasks were linked to initiating, steering, observing and summarizing the outcomes of the process. In our case, the process-leading researchers essentially assumed the role of process facilitators and were required to maintain a certain level of neutrality. Although we had topical expertise in some of the addressed themes, we mostly used our own expert knowledge to adopt an "informed rational perspective" instead of actively contributing to the discussions. Furthermore, we found ourselves in a steady tension between pro-active steering and responding to the dynamic developments of the process. On the one side, we had to reach the goal of creating a valuable output for the development of an innovation in the field of ZFarming. On the other side, the ROIR approach requires one to react to and acknowledge the dynamics and demands that emerge out of the stakeholder group. These occasionally opposing demands needed to be continuously balanced.

In the final process phase, the question of the *continuity of the innovation network* appeared to be a critical issue. Although the process has been commenced as a top-down initiation, the group could potentially have continued as a self-organized group. Several stakeholders shared the hope that the ROIR could have led to the joint establishment of a practical pilot RTG project. Indeed, the continuity of the group could not be established after the end of the research project. After the organizational efforts provided by the research team ended because of the end of the research funding, the network split into smaller functional units. Stakeholders who met and connected through the ROIR workshops are still cooperating and working together on projects. However, the attempt to establish a steady group and continue the work with the entire group of participants could not be fulfilled.

To summarize the *implications of our results for planning and management*, we found that the ROIR approach was useful as a planning tool for the joint introduction of regional innovations and that the positive impact of ROIR was perceptible and proven. Regarding smart city development, Lee, Phaal, & Lee, 2013 have stated that the integration of participation methods (e.g., workshops, interviews and surveys) enables the roadmapping process to become a communication platform for knowledge exchange at both the city and intercity levels. Although the ROIR approach focused on rural development options in the previous applications (Schwerdtner et al., 2015), we transferred the approach to a city context and an urban innovation. Previously, the approach was successfully applied to certification of the wood fuel value chain and the installation of a precision farming competence center in the region of Brandenburg (Germany). Transfer to the urban context was easy and revealed no difficulties. Comparing ROIR to conventional TRM processes (which are characterized by top-down approaches that are driven by firms and market settings), the inclusion of stakeholders in TRM can be understood as a promising expansion for future planning processes in both rural and urban contexts.

7. Conclusion

This study used the process of introducing innovative forms of urban agriculture to the city of Berlin as an application and evaluation of the ROIR approach. It was the first attempt to evaluate the ROIR approach and its effects. The most important characteristics of the approach are its openness to outcomes and the integration of interdisciplinary knowledge. Our study revealed that for the case of the innovation of ZFarming, the ROIR approach could make a positive contribution in terms of knowledge generation, establishing stakeholder networks, the implementation of new projects, and improving the general perception of the innovation. We therefore conclude that ROIR has a generally high potential as a planning tool for stakeholder-driven innovation processes, which can contribute to a sustainable development of a region. Nonetheless, the approach remains in an early stage of research and application, and there are several limitations and open questions to be solved. ROIR should be further tested and evaluated to increase its potential for the future participatory creation of innovations in both rural and urban settings.

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