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Citizens' Motivations for Engaging in Open Data Hackathons

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Abstract. Engaging citizens in open data hackathons provides opportunities for innovation and the generation of new services and products. This paper aims to explore the motivations of citizens who engage in open agriculture data hackathons. We conducted a case study and analyzed data collected from 161 participants of 11 farming hackathons held between 2016 and 2018 in the Netherlands. We found that participants of open agriculture data hackathons have different roles, including business developer, concept thinker, data analyst, data owner, developer, manager, marketer, problem owner, and student. Our analysis shows that citizens are predominantly motivated to engage in open agricultural data hackathons as part of their work. Furthermore, developers and problem owners are mainly motivated by fun and enjoyment. This indicates that it is important for open data policymakers and hackathon organizers to consider different approaches based on citizens' roles when organizing open data hackathons. This paper contributes to the literature by providing insight in the motivations of citizens engaging in open agriculture data hackathons in comparison with hackathons in other sectors, and by mapping citizens' roles to their motivations for engaging in such hackathons.

Keywords: Open Data, Open Government Data, Agriculture, Citizen Engagement, Hackathon.

1 Introduction

Open Government Data (OGD) provides opportunities for innovation [1] and for improving the daily life of citizens [2]. One particular example of a sector in which OGD is a promising source of innovation is agriculture. This sector mainly concerns the quality and sustainability of farms and their environment, as well as efficient and smart farming [3]. The use of public agricultural data potentially benefits stakeholders involved in the farming sector. For instance, farmers can improve the precision of farming processes and management by using water quality data, agribusinesses can offer smart farming products based on weather data to help farmers make decisions about when to plant a particular vegetable, and government organizations can be more accurate at giving subsidies to farmers based on fertilizer purchase data. Citizens can

engage with the mineral indicator data combined with public participation for keeping their eyes on the environmental and health impacts of farming practices as well. Using open agriculture data, citizens can contribute to solving societal challenges in feeding the growing world, environmental sustainability, food safety, and health [4].

The creation of the above-mentioned benefits requires the engagement of citizens in the use of open agriculture data. Engaging with open agriculture data, however, embraces challenging tasks in understanding and processing voluminous data captured from various sources such as sensors installed in tractors and soils, satellite imagery, soil and water indicators, and statistics [3-5]. In addition, knowledge of farming processes, as important parts of the food chain which affect sustainability and consequences on food safety issues and contribute to health, is needed [4]. Therefore, one needs to collaborate with others who possess diverse skills and knowledge required to create value out of agriculture data. Collaboration among citizens in groups to develop new OGD-based products and services is typically facilitated and stimulated in open data hackathons promoted and supported by governments [6].

An open data hackathon is an offline, face-to-face competition sponsored by government agencies in a centralized location that brings together citizens with different backgrounds (e.g., programmers, designers, students) to intensively collaborate in small teams for a short amount of time (e.g., 12 hours, 24 hours, 2 days) to create artifacts (e.g., ideas, mockups, design, prototypes, applications) using OGD [7, 8]. Typically, at the end of the competition, each team presents the final idea in front of juries, and a winning team usually earns a prize (e.g., money, investment, support). In a hackathon, organizers and sponsors provide nearly all resources and support needed by the teams to work efficiently [7, 9], including catering services, sleeping bags/area, comfortable facilities (gaming device, sports hall), internet connection, electricity (cables), and stationaries. The provision of technical support from open data providers or event organizers is also common for hackathons.

Although research on the socio-technical conditions of OGD utilization, both enabling and disabling factors, has been widely established [10], yet only a handful of studies investigate the drivers of citizen engagement in open data hackathons [11]. Previous research showed that citizens' motivations to participate in hackathons are heterogeneous [12]. For instance, in a Swedish hackathon on public transportation, the motivation is primarily associated with fun and enjoyment [12], while in a Brazilian city hackathon, contributing to solutions of social problems and networking are the main drivers [11]. These studies show the need to differentiate between different types of open data hackathons and instead of black boxing citizen engagement with OGD, the context should be taken into account [13]. This study contributes to existing research by providing insights into citizens' motivations to engage in open data hackathons in the sector of agriculture.

The main research question we aim to answer in this paper is: "Why do citizens engage in open data hackathons in the agriculture sector?" This study is among the first to provide insights on OGD engagement in the agricultural sector. It contributes to research concerning the mapping of citizens' motivations to engage in open data hackathons. The results of the study may help policymakers to formulate a strategy

for sustaining open data engagement which takes multidimensional approaches into account.

2 Research Methodology

2.1 Case Study Design

Case studies can be used to investigate a real-world situation over which researchers have little or no control [14]. Case study research is the preferred research approach for this study since we aim to answer why citizens engage in open data hackathons which is an ill-understood topic in the OGD utilization context. A multiple-case study design was selected because its evidence is often considered more convincing and, therefore, the overall study is accounted for being more robust compared to a single-case study [15].

The agricultural sector was selected because of its enormous potential to solve problems related to malnutrition, food security, sustainability, and other societal problems [4]. We examined the motivations of 161 citizens for participating in a selection of 11 Dutch hackathons in the agricultural sector held from 2016 to 2018. These 11 cases were selected for the following reasons 1) the authors have access to participant data, 2) the first author of this paper participated in two of the hackathons, namely FarmHack (FH) 6 and FH12 and obtained in-depth insight, and 3) the cases are diverse with regard to the types of outcomes competed in the hackathons (i.e., idea, design, application/prototype, visualization) and the focus of the challenges (i.e., problem-driven, data-driven, or both).

The hackathons were organized by FarmHack.NL, a Dutch company which focuses on developing an ecosystem of coders, hackers, developers, planners, designers, domain experts, civil servants and farmers that enables innovation in the agricultural sector using data and technology. Typically, each hackathon offers different themes as described in Table 1.

Table 1. The overview of eleven cases of Dutch agricultural hackathons organized by FarmHack.NL.

Code	Themes	Outcomes	Focus	Year	Respondents
FH1	Data visualization for pie farmer	Visualization	Data-driven	2016	13
FH2	Drones, satellites and crop protection	Application	Problem-driven	2016	16
FH3	From farmer to city	Application	Problem-driven	2016	12
FH4	Network technology and sustainable livestock farming	Design, application	Problem-driven	2016	13
FH5	AgriVision Hackathon	Application	Data-driven	2017	12
FH6	Manure Hack	Application	Data-driven	2017	22
FH7	Smart Dairy Farming	Application	Data-driven	2017	10

FH8	Fishing Hack	Design, application	Problem-driven	2018	21
FH10	Soil Hack Achterhoek	Application	Data-driven	2018	14
FH11	Tractor Hack	Visualization	Data-driven	2018	6
FH12	National Soil Hack	Idea	Data-driven	2018	22

To participate in the hackathons, as long as seats are available, a citizen is only required to register through FarmHack.NL's website and to complete a registration form. The hackathons were for free and the participants were provided with catering services (i.e., coffee breaks, a breakfast, two lunches, and two dinners), sleeping area, internet connection, electricity (cables), wireless network, stationaries and even a guided tour to sites or museums related to the theme. Each hackathon typically lasted for one and a half days.

Each hackathon was organized as follows. First, on the first day's morning, all participants gathered and received an explanation. Each challenge raised in the hackathon was presented by a team leader who was typically an employee of a sponsoring organization. Then, each team leader discussed the challenge in detail in a small group where interested participants joined. This activity was run twice and participants were free to change group. Next, participants chose and joined a team working for a specific challenge. Thereafter, 'hacking' started in these groups, guided by a framework developed by FarmHack.NL which contained questions that should be answered to achieve the desired solution of the challenge. The framework concerned both the technical aspects, such as data and technology involved and social aspects of the solutions. On the second day of the hackathon, teams had to present their solutions to the challenges, followed by a question and answer session, and ended by the announcement of winners and prizes they won. The prizes were varying across hackathons, ranging from 500 to 20,000 euros.

2.2 Data Collection and Analysis

Multiple sources of evidence were collected from October 2017 to February 2019 at several points in time, as described in Table 2. The collected data include the FarmHack.NL webpages, notes taken from unstructured interviews with six participants and observations in two hackathons, and multiple qualitative surveys from participant registration data.

Each type of collected data was analyzed for different purposes. Data from the FarmHack.NL webpages and the observational and unstructured interviews notes were used to describe the characteristics of each hackathon and the variance among the hackathons, while the qualitative survey data were analyzed in three stages. First, the participants' backgrounds and roles were grouped and the reasons for participating were coded based on the framework developed based on our literature review (See Section 3). We also included new codes emerged in the data. Then the codes were mapped into a classification of motivations for participating in the hackathons. Finally, the new map of roles and factors were analyzed using simple descriptive statistics (i.e., cross tabulation). The analysis was conducted by the first author and reviewed

by the second and third authors. The authors also made the qualitative survey and analysis dataset available online as open research data on 4TU Center for Research Data repository at https://doi.org/10.4121/uuid:879be853-ba9d-463d-a2db-51a076e9ce6e.

Table 2. Data collection strategy.

Data Source	Data Type
Documents	22 hackathon webpages
Survey	11 qualitative surveys (n=161)
Interviews	Notes from six unstructured interviews
Participant-observations	Notes from FH6 and FH12 observations

3 A Framework for Analyzing Citizens' Motivations to Engage in Open Data Hackathons

In this section, we develop a framework for the analysis of our cases. We do so by searching, collecting and selecting open data literature which investigates factors that influence citizens to engage with OGD or to engage in hackathons using Scopus database. We apply the combination of the following keywords *open data* or *open government data* and *use*, *engagement*, or *hackathon*. We include six publications which are deemed relevant for this study (see Table 3).

Based on the selected papers, we observed that many factors influence citizens to engage with OGD or to engage in an open data hackathon: intrinsic motivations such as fun and enjoyment and intellectual challenge [12]; extrinsic motivations concerning performance expectancy [13] or relative advantage [16], learning and developing skills, and networking [11, 12]; effort expectancy [13] related to ease of use [17]; social influence [13, 18] including contributing to societal benefits [11, 18]; and data quality [18].

We synthesize the empirical findings and propose a framework of citizens' motivations to engage in open data hackathons. Intrinsic and extrinsic motivations of a participant are viewed based on the source of rewards (internal or external) for engaging in the hackathon [19]. A developer/programmer will enjoy building a prototype/application that solves a problem competed in a hackathon. Even if the problem requires a higher level of challenge compared to the developer's current capabilities/skills, he or she will strive to solve it, because he or she feels that his or her status and reputation is at stake.

Performance expectancy and relative advantage is related to the degree to which an individual perceives that engaging in open data hackathons will help him or her attain gains in job performance [20] or will be advantageous to him or her [21]. The developer can also be motivated by delayed benefits that may be received after participating in a hackathon: learning new skills from teammates or expanding the network with prospective employers or investors.

Table 3. A framework of citizens' motivations to engage in open data hackathons.

Factors	Definition	Constructs	Source
Intrinsic motivation	"doing something because it is inherently interesting or enjoyable" [22, p. 859]	Fun and enjoyment	Juell-Skielse, Hjalmarsson, Johannesson and Rudmark [12]
		Intellectual challenge	
Extrinsic motivation	"doing something because it leads to a separate outcome" [22, p. 859]	Performance expectancy/relative advantage	Wirtz, Weyerer and Rösch [17], Zuiderwijk, Janssen and Dwivedi [13], Weerakkody, Irani, Kapoor, Sivarajah and Dwivedi [16]
		Learning and developing skills	Juell-Skielse, Hjalmarsson, Johannesson and Rudmark [12], Gama [11]
		Networking	
Effort expectancy	"the degree of ease associated with the use of the system" [20, p. 450]	Ease of use	Wirtz, Weyerer and Rösch [17], Zuiderwijk, Janssen and Dwivedi [13]
Social influence	"the degree to which an individual perceives that important others believe he or she should use the new system." [20, p. 451]	Influence from a social relationship	Purwanto, Zuiderwijk and Janssen [18], Zuiderwijk, Janssen and Dwivedi [13]
		Contribute to societal benefits	Gama [11], Purwanto, Zuiderwijk and Janssen [18]
Data quality	"data that are fit for use by data consumers" [23, p.6]	Accuracy	Purwanto, Zuiderwijk and Janssen [18]

A participant's effort expectancy is related to the degree of ease associated with the use of open data and technology for solving a hackathon's challenge. It also concerns the participant's perceived capabilities/skills required for creating solutions which reciprocally affects the perceived ease of use. The more complex the challenge, the bigger the potential of the participant for being felt bored or anxious which in turn degrades his or her motivation [24].

Participants could be influenced by their social relationships to engage in a hackathon. Supervisors might urge their employees to participate in a hackathon. Social influence can also take form as norms and behaviors established in a hackathon team to accomplish shared goals. As a result, participants will be driven to contribute to the benefits of the team or society by solving a hackathon challenge. Data quality has been associated with technical conditions for OGD utilization [10]. Hypothetically, the higher the quality of data, the more it will be used [25].

4 Results

The qualitative survey data received from the hackathon organizer consists of the potential roles of participants and the motivations they participated in the hackathons.

The organizer asked participants to select one or more roles (i.e., business developer, marketer, data analyst, developer, concept thinker, data owner, or others). If the participant's role is not provided in the list, "other" can be selected. We created ten groups of roles which include the original categories and four new groups: Manager, Problem Owner, Student, and Unknown. Manager concerns participants from managerial positions such as CTO (Chief of Technology Officer) and project managers. Problem owner represents citizens who are practitioners having expertise in the hackathon theme, for example, landscape architect and agriculture advisor. When no role was entered by the participant, we used the label Unknown. If a participant has been assigned more than one role, we group him or her into a role by considering the substance of the reasons for participation. The role group which we assigned might be different than one of the roles that the participant stated. For example, we found a participant who declared that he is a data analyst and concept thinker, but we grouped him as a student because he was a junior in a university. Another example concerns a participant saying that he or she is a business developer, data analyst, developer, and concept thinker, whom we grouped into developer because he or she wanted to use technical expertise in GIS and R programming in the hackathon. Thus, several roles were reassigned.

We evaluated the motivations for participation against the framework described in the previous section. We found that the factors that influence citizens to participate in the hackathon were heterogeneous and a citizen may be motivated by many factors. From the 161 records, we extracted 201 codes representing the reasons. These codes were grouped into the constructs proposed in the framework based on their similarity of meanings. For example, we interpreted a participant's expectancy of the manure market transparency as an aspiration to contribute to societal benefits. Motivations that did not fit in our initial framework, for example, "the conventional farming is not a sustainable system" were grouped into 'Other'. We cross-tabulated the frequency of constructs and arranged them in Table 4. Most participants mention their participation in the hackathons as part of their work (n=50) such as looking for a job or business opportunity, representing a company, or selling ideas or a product. Personal benefits such as 'winning a prize' and 'pizza' were the least mentioned by participants (n=2).

Unsurprisingly, the results showed that constructs related to effort expectancy and data quality were not mentioned by participants regardless of their roles since the data and their quality are unknown to participants and so are the efforts required for utilizing them. Although *data* was mentioned frequently in the motivations, most participants conceive that it has the potential to improve the agricultural sector, but never refer to its quality.

4.1 Intrinsic motivations

Fun and enjoyment are prominent in the developer and problem owner groups. This result indicates that the developers and problem owners enjoyed participating in hackathons specifically because of the topic itself. The developers seemed to enjoy applying technical aspects such as programming. Among these developers, three participants indicated that they enjoy hacking activities by saying "software hacking in the agro sector is my thing," and "I like working in agricultural robotics and IoT."

Interestingly, two developers have engaged in a hackathon before and they wanted to continue the hacking experience. The problem owners were interested in the topic of the hackathons because it is something that they have to deal with every day. One of them said the topic was an "interesting subject, in line with my daily practice."

Participants who were driven by intellectual challenge mainly felt challenged to apply and exchange their skills, ideas, knowledge, or expertise.

4.2 Extrinsic motivations

Work is the most influential motivation and stands out in the group of citizens in the roles of business developer, marketer, and student. Participants considered their engagement in the hackathon as part of their jobs. For example, three participants participated to collect data that can enrich their research or thesis. Thirteen participants were motivated to look for a new opportunity either for their companies or careers.

Interestingly, it appears that participants who have a non-technical background (e.g., problem owner) would like to learn more about how data and applications can help them. While those from a technical background (e.g., data analyst, developer) mainly wanted to upgrade their skills or knowledge or learn new techniques or methods.

Only five out of 161 participants said to be motivated by networking. One of them did not specify what kind of network he or she wanted to create, while others wanted to expand to a specific network. A fisherman's technician wanted to create a network with other technicians who can help design a particular trawler. A researcher sought for a network of developers and data analysts for a case study. A data analyst looked for other people who are enthusiastic about agriculture, technology, and data. And, a user interface designer wanted to get in touch with companies to show them what his or her company can do.

Only two participants mentioned personal benefits: a data analyst who wanted a pizza and a developer motivated to win a prize.

4.3 Social influence

At least four types of social entity were mentioned to be influential to the participants: supervisor (i.e., a participant's team leader), colleague (e.g., data scientist, farmer), company (e.g., FarmHack.NL), and family (e.g., uncle, partner). Usually, a participant influenced by a social relationship would also have other reasons to participate at the same time. For example, a participant who was urged by his or her supervisor to participate, inarguably, means that he or she performs a job in the hackathon.

Different reasons to contribute to societal benefits were observed. One participant wanted a change: more transparency in the manure market, while others wanted to contribute to practical improvement and innovation in the agricultural sector or encourage the involvement of the community. Some participants wanted to contribute to the teams working out for a solution to the hackathon challenges. A data analyst said that he or she wanted to work in a team "to solve a challenging problem." A developer stated that "with my experience in IT, drone technology and precision farming, I think I can make a nice contribution to this challenge." Nine participants were motivated to work in an interdisciplinary team composed of citizens from different back-

ground and discipline. By teamworking, participants can learn from each other, exchange or even create new ideas, as well as try to solve a challenge together.

4.4 Previous experience

Previous hackathon experience was a factor not found in the literature review, but our qualitative survey data showed that it was an important motivation for some participants. Four participants said that they had participated in hackathons before the FarmHacks and wanted to continue participating.

Table 4. The mapping of citizen roles and motivations to engage in open data hackathons.[1]

Category/Subcategory of Factor*	BD (n=18)	CT (n=19)	DA (n=25)	DO (n=4)	DV (n=35)	MG (n=10)	MK (n=3)	PO (n=25)	ST (n=13)	NA (n=9)	Total (n=161)
Intrinsic motivations	*27.8% (5)*	*31.6% (6)*	*36.0% (9)*	*25.0% (1)*	***57.1% (20)***	***50.0% (5)***	*0.0% (0)*	***56.0% (14)***	*23.1% (3)*	*33.3% (3)*	*41.0% (66)*
Fun and enjoyment	16.7% (3)	10.5% (2)	28.0% (7)	25.0% (1)	**37.1% (13)**	**40.0% (4)**	0.0% (0)	**32.0% (8)**	15.4% (2)	11.1% (1)	25.5% (41)
Intellectual challenge	11.1% (2)	**21.1% (4)**	8.0% (2)	0.0% (0)	20.0% (7)	10.0% (1)	0.0% (0)	24.0% (6)	7.7% (1)	22.2% (2)	15.5% (25)
Extrinsic motivations	***55.6% (10)***	***42.1% (8)***	*48.0% (12)*	***50.0% (2)***	*45.7% (16)*	*40.0% (4)*	***66.7% (2)***	*36.0% (9)*	***69.2% (9)***	*33.3% (3)*	***46.6% (75)***
Working	**44.4% (8)**	**21.1% (4)**	**32.0% (8)**	**50.0% (2)**	31.4% (11)	**40.0% (4)**	**33.3% (1)**	24.0% (6)	**30.8% (4)**	22.2% (2)	**31.1% (50)**
Learning and developing skills	5.6% (1)	15.8% (3)	8.0% (2)	0.0% (0)	11.4% (4)	0.0% (0)	**33.3% (1)**	12.0% (3)	23.1% (3)	11.1% (1)	11.2% (18)
Networking	5.6% (1)	5.3% (1)	4.0% (1)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	15.4% (2)	0.0% (0)	3.1% (5)
Personal benefits	0.0% (0)	0.0% (0)	4.0% (1)	0.0% (0)	2.9% (1)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	1.2% (2)
Social influence	*22.2% (4)*	*31.6% (6)*	***56.0% (14)***	*25.0% (1)*	*17.1% (6)*	*10.0% (1)*	*0.0% (0)*	*32.0% (8)*	***46.2% (6)***	*33.3% (3)*	*30.4% (49)*
Social influence	11.1% (2)	5.3% (1)	28.0% (7)	0.0% (0)	8.6% (3)	0.0% (0)	0.0% (0)	4.0% (1)	0.0% (0)	33.3% (3)	10.6% (17)
Contribute to societal benefits	5.6% (1)	10.5% (2)	8.0% (2)	0.0% (0)	2.9% (1)	0.0% (0)	0.0% (0)	16.0% (4)	**30.8% (4)**	0.0% (0)	8.7% (14)
Teamwork	5.6% (1)	5.3% (1)	8.0% (2)	25.0% (1)	0.0% (0)	10.0% (1)	0.0% (0)	8.0% (2)	7.7% (1)	0.0% (0)	5.6% (9)
Contribute to challenge	0.0% (0)	10.5% (2)	12.0% (3)	0.0% (0)	5.7% (2)	0.0% (0)	0.0% (0)	4.0% (1)	7.7% (1)	0.0% (0)	5.6% (9)
Previous experience	*0.0% (0)*	*0.0% (0)*	*4.0% (1)*	*0.0% (0)*	*5.7% (2)*	*0.0% (0)*	*0.0% (0)*	*4.0% (1)*	*0.0% (0)*	*0.0% (0)*	*2.5% (4)*
Others	*0.0% (0)*	*5.3% (1)*	*8.0% (2)*	*0.0% (0)*	*2.9% (1)*	*10.0% (1)*	***33.3% (1)***	*0.0% (0)*	*0.0% (0)*	*11.1% (1)*	*4.4% (7)*

Notes: * In % (absolute number of respondents)

BD=Business Developer, CT=Concept Thinker, DA=Data Analyst, DO=Data Owner, DV=Developer, MG=Manager, MK=Marketer, PO=Problem Owner, ST=Student, NA=Unknown

[1] The table has been made available on 4TU Center for Research Data repository at https://doi.org/10.4121/uuid:29296049-0222-4df3-9ba7-acdd4949d1b9

5 Discussion

The results show that most citizens (n=50) appear extrinsically motivated by work-related performance to engage in the open agricultural data hackathons. In contrast, citizens with the developer and problem owner roles (n=21) are intrinsically motivated by the fun and enjoyment that open data hackathons bring. This finding is in line with previous research investigating the motivations of participants of open transportation data hackathons in Sweden [12], and open city data hackathons in Australia and New Zealand [11].

From the results, we can observe that, on the one hand, most citizens seemed to be driven by only one motive (130 out of 161 participants). On the other hand, some were influenced by multiple motives (31 participants). Citizens who have only one motivation appeared highly motivated because they focus on only one goal in a hackathon, while citizens with multiple motives might want to continually engage in the hackathons until their multiple goals are achieved. Indeed, individuals, such as hackers engaging in free/open source software projects, can be influenced by different, and sometimes contradictory, motivations [19].

Focusing on the multiple motives-driven citizens, we suggest that a pattern of hierarchical relationship exists between motivations, especially social influence and work. A citizen who was asked by his or her supervisor (socially influenced) to engage in a hackathon for delivering support for participants is one of the examples of hierarchical motivation. This implies that participating in a hackathon as part of employment is sometimes determined by social influence as suggested by Zuiderwijk, Janssen and Dwivedi [13].

Work, observed as the main motivation, indicates that most participants prioritize their personal gains. Work also indicates that many companies will likely send their employees to participate in hackathons to look for an opportunity to expand their businesses. Within this frame, we can assume that profit-oriented themes are the most preferred in the context of open agricultural data use. This further indicates that companies are valuing the economic impacts of using open data. Hence, stimulating agriculture companies to become involved in open agriculture data engagement is an important agenda for open data policymakers and hackathon organizers.

6 Conclusion

This paper aims to explore the motivations of citizens who engage in open agriculture data hackathons. Based on a case study of 11 open agriculture data hackathons held between 2016 and 2018 in the Netherlands, we found that participants of these hackathons have different roles, including business developer, concept thinker, data analyst, data owner, developer, manager, marketer, problem owner, and student.

This paper sheds light upon the mapping of factors (i.e., intrinsic motivations, extrinsic motivations, effort expectancy, social influence, and data quality) that drive citizen engagement in open data hackathons based on their roles. In the cases we studied, most of the surveyed citizens were driven by extrinsic motivation, i.e., perform-

ing work. They considered their engagement as part of their work performance. However, among the examined roles, most developers and problem owners appear to be influenced by intrinsic motivation related to the fun and enjoyment of being engaged in the hackathons. Among the analyzed factors, effort expectancy and data quality seem to be uninfluential since no participants mention reasons associated with these factors. This is predictable because the quality of the open agricultural data and the efforts required to utilize the data are unknown to participants.

The above-mentioned conclusions indicate that a pattern of relationship exists between motivations and roles and thus, this study advances the discussion to identify different roles which were not investigated in previous research on the motivations of citizens in hackathons. Our results show that it is important for open data policymakers and hackathon organizers to consider different approaches based on citizens' roles when organizing open data hackathons. Hence, a different strategy should be used to involve, for example, citizens sent by companies compared to developers and problem owners who join the hackathon because they like to discuss the topics of the hackathons.

The limitation of this study concerns the intermediating factors such as personal background (e.g., age, gender) or other situational conditions (e.g., how far the hackathon location is from a participant's house) which might play a role in citizens' motivation but were not taken into account. We suggest that future research explores the relationship between intermediating factors and citizens' motivations.

This paper contributes to the literature by providing insights in the motivations of citizens engaging in open agriculture data hackathons in comparison with hackathons in other sectors, and by mapping citizens' roles to their motivations for engaging in such hackathons.

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