Barriers to Digitalized Co-production: the Case of Volunteer First Responders

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ABSTRACT

Information and communication technology (ICT) and digitalization are often seen as enablers of co-production. But if its potential is not implemented, technology will rather act as a barrier. In Sweden, new types of "hybrid" co-production initiatives that engage civil citizen volunteers as first responders emerged a decade ago. Even though the benefits are recognized, the initiatives' expansion are hampered by the ICT solutions. In this study, we explore why, by comparing the perspectives of national authorities, needs-owners, suppliers, and end-users. We describe the barriers, e.g., insufficient geofencing, to develop ICT for various mobile platforms, unavailability of a joint API, competitiveness and double roles among stakeholders, and ICT costs. We suggest how to address the barriers and argue that digitalized co-production of the type presented will likely increase. Here our study can contribute to the successive accumulation of knowledge.

Keywords

digitalization, co-production, ICT, volunteers, emergency response

INTRODUCTION

The potential of digitalization to deliver benefits to public service delivery including interaction with civil citizens, is sometimes referred to as *co-production*. (Ostrom, 1996). Recent studies argue that digitalization and information technology (ICT) enable and transform co-production (e.g., Lember et al., 2019; Paletti, 2016). Related research often focuses large-scale citizen engagement enabled by social media, crowdsourcing, and living labs (Marino and Lo Tresti, 2018; Granier, 2016). This includes emergency management that mostly relates it to large-scale crises, e.g. floods, earthquakes, pandemics, and to spontaneous volunteerism (Yeo and Lee, 2020; Velotte and Murphy, 2020). It is also rather technology optimistic (Rodriguez Muller, 2020; Paletti, 2016). This has been pointed out by Lember et al. (2019) who claim lack of evidence and argue that there is no reason to assume that digital technologies will always encourage co-production.

In Sweden, co-production emergency response initiatives of a "hybrid" type emerged a decade ago. They did not involve citizens on large-scale or the public but rather targeted efforts to recruit groups of citizens to provide first response for other citizens in frequent accidents. Substantial benefits in terms of shorter response times, saved lives, reduced human suffering and material damage, have been recognized by the national authorities and the fire rescue services alike. Nevertheless, the initiatives' expansion to most municipalities remains limited. One reason are them being hampered by still having to rely on basic SMS-lists for dispatch. Apps developed for the purpose is used only by one large fire association. A national standard app has been under development by the Public Swedish Answering Point (PSAP) for five years with no release. In this study, we explore why the ICT used has become a barrier rather than an enabler. This, by comparing the perspectives of national authorities, needs-owners (rescue services), suppliers, and end-users (volunteers).

Study aim

The aim of this study is to explore why digitalization/ICT sometimes act as a barrier to effective co-production, using volunteers as first responders as an example. We identify the barriers that relate explicitly to the ICT artefact.

We also provide suggestions on how to reduce them. The study's main contribution is oriented toward digitalized co-production in emergency response. The study is also relevant to large-scale crisis management since the same volunteers and similar ICT will likely be used in a crisis. It also has a general scientific contribution in that it discusses implications for digitalization in emerging public sector "hybrid" co-production forms.

BACKGROUND

In co-production, citizens are part of public services' design, steering, and management (Ostrom, 1996). Co-production is increasingly seen as a necessity when public sector resources are cut, e.g., in emergency response. It does not explicitly presume digitalization or an ICT artefact. Several recent studies have however emphasized the increasing role of digital technologies, using terms like "ICT as an enabler" and "ICT facilitated co-production" (e.g. Rodriguez Muller, 2020; Paletti, 2016). Fewer studies focus related barriers. Lember et al. (2019) claim that the debate has been characterized by conceptual fuzziness and technology optimism where challenges such as investment of resources and motivation of citizens are not sufficiently addressed. They also note that most studies focus social media and crowdsourcing. Yuan (2019) performed an extensive literature review on co-production and ICT and identifies potential barriers in a few studies. They include, among other things, costs for ICT platform maintenance. Clifton et al. (2020) argues that the majority of such studies focus structural and cultural barriers to digitalized co-production. This is also reflected in Yuan's review.

Velotte and Murphy (2020) argue that the traditional definition of emergency services as performed by trained professionals, should now also include co-opted or spontaneous volunteers, and that the new approach is radical. Meanwhile, most studies on using volunteers in co-production, relate it to large-scale crises, and to spontaneous volunteerism (e.g., Yeo and Lee, 2020). Also, they do not speak explicitly about digitalized co-production. There are a few exceptions, where ICT enabled/digitalized co-production is used to frame the involvement of volunteer first responders in frequent emergencies (Pilemalm, 2021; Ramsell et al. 2017). We define this as an emerging *hybrid* type of volunteerism. This in comparison to organized volunteers (belonging to an organization, e.g., the Red Cross) or spontaneous volunteers that show up at an incident site or are self-deployed in a crisis, often using social media. The volunteers in the study engage in long-term collaboration with the rescue services. At the same time, they are organizationally unaffiliated, i.e., the rescue services have no formal responsibility for them. This is closest to the co-production type *citizen-sourcing* (Yuan, 2019), where government organizations make an open call to a large community of citizens to exploit their skills for tasks of public services. However, the hybrid type of co-production also deviates from this definition, since targeted efforts, information campaigns, local interest groups and outreach work is used, while citizen-sourcing is mainly achieved using on-line requests and platforms.

In summary, we see several gaps in previous research on digitalized co-production. It speaks of opportunities rather than ICT related barriers and outcomes. It focuses large-scale groups of citizens/the public from a governmental perspective rather than local initiatives and/or hybrid forms. In crisis/emergency management, studies on digitalized co-production are generally few. We address the perceived gaps when studying the volunteer initiatives in Swedish emergency response, and why the ICT which set out to be an enabler of co-production, became a hindrance of the very same co-production.

Study Context

In Sweden, about 300 municipal rescue services are responsible for accidents and to reduce their consequences (SFS 2003:778). The PSAP handles all incoming emergency (112) calls and dispatches the adequate resources. In the initiatives, volunteers act as first responders in collaboration with the municipal rescue services. Civil citizens are recruited, receive basic training and equipment (Figure 1). They are then alerted and dispatched to certain traffic accidents, smaller fires, heart failures, and drownings, if they are within a certain radius of the incident site. The idea is a faster response since the volunteers can start first response/aid before the professional resources arrive. The concept emerged a decade ago in sparsely populated areas with a long distance to the response organizations. It has been argued that it is a key to an efficient incident site where people's lives have been saved, fires extinguished before they spread and where response times are reduced, both in rural and urban settings (Ramsell et al., 2017, Pilemalm, 2021). It is also deemed cost-effective. This, since costs are low compared to a professional response resource and the benefits obtained from a single response, where the volunteers were able to contribute, will highly exceed the costs for the responses where they were not (Weinholt and Andersson Granberg, 2015). The ICT, - SMS lists - were a central initial enabler of an informal structure of the co-production. Later, the app was another enabler of digitalized co-production by allowing dispatch of volunteers providing geographical positioning (Pilemalm, 2021).

Figure 1. Example of equipment kit provided to volunteers

However, nationwide, there are still comparatively few rescue services that have implemented the concept. Some identified challenges are (inter)organizational, e.g., lack of defined responsibilities. Some relate to keep the volunteers motivated over time, others to legal aspects (Ramsell et al., 2017). A fundamental barrier relates explicitly to the ICT where available app technology is not used to a large extent. The SMS-lists were intended as an initial solution but became both enabler and hindrance to the co-production, mainly since they have no GPS-positioning. Thus, the rescue services, ten years later, are left with a situation where the ICT has become a hindrance for further expansion. Digitalization has not become the enabler it was intended to. Thus, while previous research mainly explored ICT as an enabler of digitalized co-production, in this study we address the barriers, and ways to handle them.

METHODS

The data collection was performed as semi-structured interviews adhering to the principles of creating an interview guide with different research themes, but also allowing for free associations of the respondents (Myers, 2009). Eight respondents were interviewed, representing various study perspectives. Two of them had double roles, i.e., represented double perspectives. The respondents included, first, an expert from the national authority that coordinates emergency management in Sweden. The respondent was one of the initial drivers of the volunteer first response concept. Second, two suppliers who have developed commercial apps for volunteers. The first app is used by one of the largest fire associations. The second app is used for spontaneous volunteers in search for missing people. However, the supplier has added functionality to suit the first response concept. Third, a respondent who works with the volunteer first response on behalf of the PSAP. The Swedish PSAP is half state, half private owned with its own app under development. The respondent thus represents both the needs-owner (dispatch of volunteers) and supplier perspective. The needs-owners are further represented by a respondent from the rescue services, who is the leader of the largest volunteer initiative, taking in a large fire association outside the capital of Stockholm. The initiative includes both urban and rural settings. Another respondent comes from a research foundation which is related to the national authority. The respondent is also active as a volunteer. He thus has a double role of expert and end-user. Finally, the end-user perspective is represented by two additional volunteers active in rural and urban settings in the municipality outside Stockholm. The respondents are summarized in Table 1 and the various perspectives in Table 2.

Table 1. The study respondents

Respondents	
National authority	1
Research foundation related to national authority	1
Supplier (IT-companies)	2
PSAP	1
Rescue Services	1
Volunteers	2
Total	**8**

Table 2. The various roles/perspectives represented in the study

Perspectives	National	Supplier	Needs-owner	End-user	Total number of perspectives represented
	2 (1+1)	3 (2+1)	2 (1+1)	3 (2+1)	**10**

Data Analysis

The respondents constitute a strategic sample (Myers, 2009) in that they have been chosen to represent various perspectives on the concept and the related ICT. We deemed it necessary to use this sampling strategy since the volunteer initiatives are not established at large scale. Thus, we needed to reach people who have sufficient experience of them. All interviews were carried out on-line using zoom, due to the pandemics. Each interview took 1-1,5 hours and was carried out by one researcher. The interviews were recorded, and audio files re-visited when complementing the memory notes and for citations. We carried out a thematic analysis (Myers, 2009) in which we clustered data into themes relating to the ICT and associated barriers. It should be noted that the data collection was broad also including status of the volunteer concept and organizational challenges. For this study, we focus on the ICT.

RESULTS

We present ICT as a potential barrier to digitalized co-production, divided into the various themes.

Various ICT Systems in Use

All municipalities but one still relies on the SMS-lists, mainly due to cost reasons. There are several limitations to this. According to the needs-owner from the rescue services, its most central barrier to effective response is that the volunteers are not dispatched by geographical positioning and sometimes do not even receive the co-ordinates of the incident site. The app provided by supplier 1 is implemented only at the large fire association in the study (Figure 2). The major functionalities include alert and dispatch through geofencing. Critical alerts go through also when a mobile phone is set to "do not disturb" mode. They also include a chat connected to position, where volunteers can communicate with each other, a map with navigation to the incident site and messages displaying basic information of the incident (e.g., type and number of casualties). Supplier 1 points out that developing an app solution for civil citizens is substantially technically more complex than developing for organizations. This, since an organization usually have one system platform while the volunteers use various android and iPhone versions.

Figure 2. The app used to dispatch volunteers.
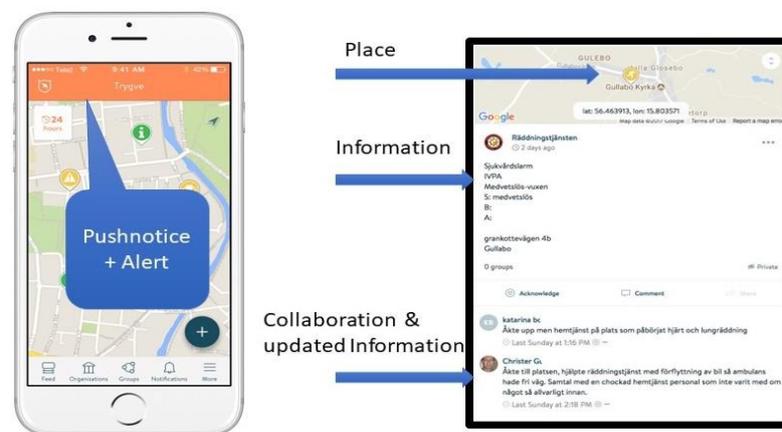
The app provided by supplier 2 is used for coordinating spontaneous volunteers. The idea is to allocate the right volunteer with the right competence to the right place and task, something we call *dynamic resource allocation*. Examples of functions are a common operational picture based on geofencing where you can see volunteers move in real-time. Thereby you can keep them out of the wrong places and directly allocate tasks. It also includes information to volunteers during a search, surveys that may be turned into after-action-reviews and where you may ask for support, instructions for equipment, etc. There is no control mechanism of who sign-up as volunteer. The app is not applied in any first response volunteer initiative, but the respondent argues that it is easily adapted to this context. He is currently in dialogue with several rescue services, but expresses frustration as to the slowness in this process and requests national coordination:

> *with some economical support for working with integrating and launching our solution to the rescue services this will only require a short period of time, say about four months. I can even do some work for free....but there seems to be no interest for this support*

The app by the PSAP has thus been under development for more than five years, which is also acknowledged by

the PSAP respondent. The main explanation is technical complexity and that they, as alarm operators, must provide a robust and secure solution. As for autumn 2021 they are "closer than ever to release". In the app, one can sign up as volunteer. The rescue services then verifies that the person is suitable (e.g., do not have a criminal record). Major functionality includes alerts (also when mobile phones are in quiet mode) with basic information on the incident and receipt of alert. As volunteer, you only receive additional information if you provide a receipt/acceptance. There is also a withdrawal function should a situation turn into something dangerous. There is no map or chat functionality. Thus, you do not know if you go on the alerts on your own or not. The needs-owner from the rescue services, tells that they will not start testing the PSAP app before its geofencing functionality works which does not seem to be the case. Lacking geofencing may work in small communities with few alerts, but not in urban settings. In the central part of the municipality, not having geofencing displaying a narrow radius, implies that a volunteer will receive 3-4 alerts per night which will lead to alarm fatigue. In the long term, they will switch to the PSAP app, not because it is necessarily better, but for cost reasons. Since the PSAP provides an overall agreement, the costs can be "hidden" among other services they provide to the rescue services. The withdrawal function also plays a major role, since an app without this functionality, might expose a volunteer to a dangerous situation (e.g., fires in cars turning into shootings).

System Relations

Supplier 1 says that their app dispatches volunteers through the rescue services back-office systems, i.e., they are not connected to the PSAP system. He is critical to the PSAP who he believes strain market competition through not releasing their API/interface for other ICT solutions to jack into. This means that other apps cannot implement certain central functionalities. The respondent argues that since the PSAP wrap their solution in an overall reduced offer they lock the rescue services to their solution. He asks whether the PSAP is a private or a public actor here. Supplier 2 states that if the PSAP will come up with an app that is equivalent to those of commercial suppliers, response organizations will pick their solution without doing a procurement. The needs-owner from the rescue services thinks that the PSAP should not develop apps at all but concentrate on the API which they can then sell. Their technical development does not seem to work which severely inhibits those rescue services using or wanting to use volunteers. He points out that the dispatch function is central to the volunteer initiatives, and the major challenge for now. The rescue services are dependent on the PSAP and therefore a "status quo" has emerged.

The PSAP respondent on the other hand, claims that they will release their API once their app is ready and that they are positive to a free market and various solutions. They invest in basic functionality that other actors can complement or mimic. He sees their role as suppliers of basic services so the recue services will not have to build themselves but can add modules if needed. Their taking a fee is rather to support the rescue services in building a sustainable, expandable organization for volunteers. Too expensive systems will make the rescue services tire. The respondent, does not, however, believe that all solutions will survive, and that standardization of some app functions are necessary. Currently, the PSAP has its own server client, speaking with its own systems.

The suppliers argue that the PSAP should release their API before their app. Otherwise, competitors cannot build secure solutions. The national expert agrees to a diversified market and states that there are several quality apps available but that these are difficult to sell to more than individual rescue services due to associated costs. Here maybe the national authority must act as coordinator in the development of standardized basic functionality. The choice will likely be the PSAP since they are alarm operator. The major challenge is who is to operate and manage the systems over time. The national expert, in contrast to the suppliers, believes the PSAP strategy is out of causality and necessary due to juridical risks of open data, connected data sources etc. However, in the long-term, release of a joint API is necessary. The respondent from the research foundation agrees that it is easier to put effort into one basic solution, manage it over time and add modules. The solutions must also be economically beneficial to the rescue services who will select the cheapest, not necessarily the best alternative. They would also rather pay the PSAP than to pure commercial actors. As to why the PSAP app is not yet released, supplier 1 believes that the organization has underestimated the technical difficulties in developing ICT that run on different android platforms, since they have not done this before:

> *We still have the challenges five years after we started working with this. So why would not they.*

Supplier 2 and the rescue services' needs-owner also believe that the PSAP have problems with their geofencing and that problems seem technical rather than security related. The final statement on release was that it should take place the third quarter 2021 but this has still not happened. The PSAP respondent, on his part, points out that apps must be disconnected from the work environment of the alarm operators, e.g., automatized alerts. This to avoid work overload. This is one tough part of the development process and causes delay. The commercial app in use however applies manual parallel handling of alerts, to avoid automated mistakes.

The respondents describe negative consequences of various ICT solutions being in orbit. The respondent from the research foundation describes things as "messy". When he acts as volunteer/end-user, he receives double messages

from SMS-lists and the app. Some volunteers handle this and accepts unstable technology while others quit. End-user 1 tells that in his community they have even resumed the SMS-solution since it is deemed more reliable than the app as to receive the alerts. End-user 2 believes that double alert systems are good, since none of the solutions work properly. She does not receive the app alerts but the SMSs sometimes. In the SMSs however, one must connect the coordinates to google maps yourselves losing time and they do not go through if you have your mobile in quiet mode. But the chance that you receive the alerts one way or the other increases.

Supplier 2 claims that several rescue services have expressed interest in their solution awaits decisions from other actors. Commercial actors will not be able to procure since there are no options to procure against. Supplier 1, on the contrary, argues that authorities should not point at one alternative. He proposes an investigation describing advantages/disadvantages with various solutions and says that choice of solution is no lifetime decision. Rather, it is easy to change if you access the API and have procurement guidelines. The emerging picture is thus one of conflict and various perspectives contradicting each other. This is also confirmed by the national expert who states that there are:

> *plenty of conflicts, in the organizations and among the rescue services and sometimes between the large rescue services and the PSAP.*

Several of the large rescue services want the authority to develop a parallel joint national app. However, this is not practically and economically feasible, according to the expert.

Dynamic Resource Allocation

Supplier 1 argues that dynamic resource allocation is an unused resource since volunteers in some small municipalities now extend 100 persons which are too many acting on all alerts. It would be possible to have volunteers specialized towards traffic accidents, fires, drownings and apply a flexible radius depending on what area you are in. They have the technical engine to dispatch based on competence. The PSAP have the functionality to dispatch based on capability in another version of their app. The PSAP respondent says that they currently discuss how this could apply also to volunteers, with specialized volunteers going to heart failures, fires etc. It should be possible to select a resource depending on who are closest to the incident site, not all these positioned within a certain radius. Somewhat ironically, the only app who *has* dynamic resource allocation functionality is the app used for spontaneous volunteerism. According to supplier 2, it includes 153 properties to select from making it possible to create specific volunteer profiles. Templates support co-ordination of right competences and equipment, e.g., access to vehicles. The respondent from the research foundation/volunteer suggests that it should also be possible for a volunteer to pre-select their personal profile and what emergencies they will respond to. For instance, some volunteers do not act on traffic accidents anyway (because they know these may involve mortally injuries) but act on fires. End-user 2 suggests that with dynamic resource allocation, it would be possible to use volunteers in more types of alerts. For instance, she works in the Prison and Probation Service and is used to handling suicidal situations. The needs-owner from the rescue services on the other hand problematizes dynamic resource allocation claiming that:

> *without a well thought out alarm strategy dynamic dispatch may become restrictive rather than effective.*

For instance, if a volunteer having special competence is near an incident but another volunteer is nearer, which one should go? This will likely vary with situation. This is confirmed by end-user 1 who is basically positive but points out the need for a carefully thought-out alert strategy, e.g., to ensure that not the same volunteers are dispatched to too many incidents.

End-user Perception

According to supplier 1, the volunteers have high demands on the app and are active in posing own requirements. On androids they do not always receive the alerts in time, which make them frustrated. Otherwise, they seem satisfied. A problem, however, related to positioning, is that the volunteers receive the co-ordinates from the back-office system and sometimes these are inexact. Then, they blame the supplier. The supplier has attempted to solve this by developing the chat version so that the volunteer first to find the incident site can inform the others. This picture is confirmed by the respondent from the research foundation, in his role as end-user. He thinks the app is "good enough" even if there is always room for improvements and adding of functionality. He also notes that the app seems to work better on iPhone than androids. The needs-owner from the rescue services also rather blame old android versions when there are technical difficulties. He notes that the app has improved much over time and agrees that supplier 1 has been responsive in gradually improving it, based on user input. End-user 1 confirms that they have collaborated with the supplier in looking at maps, and re-distribution of geographical areas when geofencing is incorrect or alerts do not show up. He simultaneously points out that the current version does not work satisfactorily, especially if you are on an android. Some volunteers do not receive alerts, must open the app to see them, or receive delayed alerts, which make them arrive too late. He has compared time differences between

app and SMS-alerts and sometimes it is substantial. He concludes that when the app works, it is fine. But its lacking in reliability makes it difficult to keep volunteers motivated over time:

> *People ask the question: was there an alert? They get tired. Especially those who lives in rural areas where they are really needed.*

This is similarly argued by end-user 2 who experiences similar problems, even though she and he partner (who is also a volunteer) have the same iPhone versions and the same installations. Sometimes they "sit next to each other in the sofa and one of them receives the alert but not the other". She talks about a traffic accident in which five youth were involved and one died, that were minutes from her home. However, she did not receive the alert, but a neighbor came to get her. Also, if you log out of the app, it may be difficult to log in again. Therefore, she does never log out, even if she is in a place where she is not able to go on the alert.

As to the PSAP app, end-user 1 has another version of it developed for functional defense and agrees that this version works sufficiently. However, sometimes information "disappears", implying that you must take screenshot not to lose it. The respondent from the research foundation, uses the same app version when working as part-time fireman, and thinks it works well. It needs some re-development to be usable for volunteers, though. The PSAP respondent claims that they have started testing the volunteer version with volunteers and some fire services (i.e., not sharp use) but have not yet had time to take care of initial end-user testing experience. The needs-owner from the fire association says they have not been involved in its development but potentially some other rescue services. Still, he believes that the development mainly takes place "behind closed doors" and that volunteers do not seem to have participated.

Secrecy

The suppliers and the PSAP respondent claims that they have designed the apps to follow existing EU-regulations on GDPR (in comparison to the SMS-lists which are open and volunteers identifiable). However, the PSAP respondent believes that following regulations, on secrecy (e.g., the Patient Data Act), and GDPR in combination with open data is a challenging part in the development process requiring much work on part of their lawyers. If you provide too detailed information on address, apartment number etc., the identity of a person can be revealed, which is legally questionable. The organization must balance this and are confident that they will solve it. The suppliers do not experience the same problem. On the other hand, the respondent from the research foundation/end-user says that there are occasions when it is possible to identify victims from the information, especially if there is a small community and/or a villa neighborhood. The rescue services' needs-owner similarly points out dilemmas arising if a volunteer is at the fire station while medical alerts are announced, and they overhear them. End-user 2, on the contrary, thinks that there is too little information in the alerts, and that secrecy issues may refrain volunteers from going if they do not know what to expect at the incident site. She mentions a situation on medical alerts when the volunteer in question did not know that it was a cardiac arrest, was in chock and unable to help when arriving.

Follow-up functionality

Several respondents agree on the need to develop functions that enables measures of effects of using volunteers. The PSAP respondent claims that they need to become much better in connecting the current incident reports with effect measures in the app such as "who was dispatched", "response time", "time at the incident site". Supplier 2 points at the possibility to extract statistic data from the app. The respondent from the research foundation also points at the need to follow data and save information. For instance, it would be good to register when a volunteer arrives at the incident site and when they leave. It is possible that the foundation could support this by creating a function to collect information over time, at a low cost. The national expert is also clear about the substantial need to study the effects of volunteers in quantitative terms.

DISCUSSION

Many studies show that governmental objectives commonly associated with digitalized co-production include efficiency and engagement, against a background of strained fiscal resources (e.g., Voorberg et al. 2019). Governments use ICT to reduce the cost of information sharing and to scale-up networks of public involvement for co-production with low expenditure (Brabham, 2009). Our study is a clear illustration of similar reasoning in emergency response. Even if the volunteer initiatives are local and bottom up, there is hope that they will increase efficiency of first response at a low cost. Other studies demonstrate that ICT enabled co-production improves service quality, resulting from incorporation of citizens' resources to complement professionals' expertise. (Sombro et al., 2017). This also relates to emergency response. Complementary efforts of volunteers have on many occasions, saved lives and property. Meanwhile, digitalized co-production is an emerging phenomenon. Lember et al. (2019) calls for more studies focusing the actual outcomes. Our study reflects this notion as we

describe outcomes of local initiatives emerging in emergency response a decade ago. We conclude that the initiatives have not had the progress as was expected. This is due to intertwined organizational barriers (e.g., potential work overload for operators, market competition, the PSAP double state-private role, different views on secrecy) and technology related hindrances (geofencing, robustness, difficulties to build reliable ICT-solutions for various platforms). As a result, we have a somewhat chaotic situation where double dispatch systems are in use, the dispatch is potentially risky, and where some volunteers have retorted to the SMS-lists they started out with ten years ago. The barriers to dynamic resource allocation and extracting statistical data have to do with organizational immaturity. The technology is available, but the rescue services must have the overall volunteer concept up and going – and access to the API - before a step towards specialization, dispatch strategies and "proof of concept" is possible. Putting the analysis in a wider context, barriers to digitalized co-production include governmental inability to integrate citizens' contributions, additional work or needed professional staff training, skepticism among public employees, citizen engagement over time, and costs for ICT platform maintenance (e.g., Kurniawan and de Vries, 2015). The two latter is certainly present in our study. However, surprisingly few, if any, studies explicitly focus the barriers built into the ICT artefact itself. Meanwhile, our study shows that it has become a central barrier to the expansion of the digitalized co-production.

In emergency management, studies on digitalized co-production are scarce, mainly relates to large-scale crises, spontaneous volunteerism, and speak about opportunities. For instance, Chatfield et al. (2013) points out how rapid information exchange can facilitate real-time citizens' contributions to co-production in tsunamis. Here, we contribute to advance knowledge on bottom-up, local hybrid initiatives where the volunteers are a defined, smaller group of citizens. The study illustrates how digtitalized co-production takes place outside clear governmental/organizational boundaries but nevertheless moves between organizations and ICT artefacts, with consequences for the design/non-design of the technology. The identified dispatch barriers contribute to higher risks, that people do not go on alerts, express larm fatigue or even resign as volunteers. Thereby, design deficiences contribute to limit or endanger the volunteer initiatives. A conclusion is that emerging, hybrid forms of digitalized co-production need more national coordination and steering, than for earlier types of volunteerism in emergency management. This goes for those organizational challenges that are not included in this study but also for development, integration and handling of the ICT artefacts.

CONCLUSION AND FUTURE WORK

Translating the study results to recommendations and conclusions, the suppliers, the national authority and the PSAP agrees that various solutions for various purposes, connected through a joint API is the way ahead, but have much different time perspectives. Market competitiveness and unclarity of the PSAP role with monopoly on broad agreements to the rescue services, contributes to the delay. There is no straightforward way to handle this. However, since the respondents point at similar interests (even if there may be hidden agendas), a first step is to simply talk to each other and define a joint strategy. The national authority seems to have an interest to co-ordinate future volunteer efforts. Their respondent mentions development of quality assurance processes, licensed training, and certifications of volunteers. We suggest that they also develop an expert group including people with technical expertise, representatives from the needs-owners, the PSAP, and end-users, for building the API and develop standardized basic app functions. For end-user involvement they can also use existing horizontal networks of rescue services working with volunteers, which we know have much experience and suggestions, also on the ICT. To release the API in near time seems a priority. Without it, suppliers cannot implement withdrawal functions, which exposes volunteers to unnecessary risks with potential consequences that can endanger the entire volunteer concept. In a wider digitalized co-production perspective, we conclude that the emerging hybrid forms need to maintain a balance between self-steering and (inter)organizational co-ordination with national support, between decentralization and centralization - if they shall survive and expand.

The study is based on eight interviews and the respondents may not always be representative of their stakeholder group. Two of the respondents had double roles, the national expert and needs-owners are drivers of the concept, and the suppliers have a commercial interest. All this may have affected the study results. At same time this demonstrates the intricate complexity of digitalized co-production where double roles of stakeholders may also contribute to ICT as a barrier. However, the research needs to be tested and replicated with more respondents in similar contexts. Our future research includes reaching out to more respondents, prototyping and testing functionality for dynamic resource allocation, and carrying out quantitative effect measures. We will thus continue focus on emerging hybrid forms of co-production, including enablers, barriers and long-time perspective evaluations, to successively add to the scientific knowledge base in this domain.

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