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Transforming Government by Leveraging Disruptive Technologies: Identification of Research and Training Needs

Maria A. Wimmer*, Gabriela Viale Pereira**, Alexander Ronzhyn* and Vera Spitzer*

** University of Koblenz-Landau, {wimmer | ronzhyn | vesp91}@uni-koblenz.de*
*** Danube University Krems, gabriela.viale-pereira@donau-uni.ac.at*

Abstract: While the public sector traditionally lags behind business in innovation, significant changes are anticipated with the broad diffusion of so-called disruptive technologies. The use of such technologies in public service, along with possible benefits, need to be well researched, and challenges be carefully discussed, analysed and evaluated. This paper applies scenario-based science and technology roadmapping to identify research and training needs in the implementation of disruptive technologies in public service. 70 experts reviewed 13 future scenarios and derived a number of research and training needs regarding internet of things, artificial intelligence, virtual and augmented reality, big data and other disruptive technologies. The identified needs serve as a starting point for a broader and more informed discussion about how such new (disruptive) technologies can be successfully deployed in the public sector - leveraging the benefits of these technologies while at the same time constraining the drawbacks affiliated with them.

Keywords: digital government, disruptive technologies, research needs, training needs, scenario-technique

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1. Introduction

The emergence of new innovative technologies leverages faster digital transformation in the public sector. Disruptive technologies offer potentials of making governments more efficient, effective, open and transparent, which are core desiderata of public sector modernization (Cordella & Bonina, 2012; Heeks, 1999; Milakovich, 2012; Weerakkody, Janssen, & Dwivedi, 2011). Therewith, citizen and stakeholder involvement in data provision and co-creation moves on to a next level of engagement.

Digital transformation characterizes the attempt of modernizing government and public service provisioning through the use of information and communication technologies (ICT). Digital government or electronic government (both concepts are used synonymously) coin the core concept for the provision of digital public services. Both terms characterize the desire of increased efficiency, effectiveness and improved quality of services for citizens and businesses through the use of ICT as is argued in many scientific publications (see e.g. (Brown & Brudney, 2001; Fang, 2002; Gil-Garcia & Martinez-Moyanoc, 2007; Yildiz, 2007)). Over the past two decades, both conceptual terms adjusted their breadth and depth of the understanding along with the changes in the expectations and needs of citizens and the increasing ubiquity of technology in society. While recently, 'digital government' is more commonly used in international scientific literature, the term 'electronic government' is maintained mostly in more practitioner-oriented strategies and implementation contexts of government actors. In this paper, we therefore continue to use digital government.

The changes in the way public services are provided evidence distinct stages of the digital government evolution (Baumgarten & Chui, 2009; Mukabeta Maumbe, Owei, & Alexander, 2008). Cathegorizing the initial digitalization with Government 1.0, the increase in participatory services and social media use by the public bodies parallel to the emergence of Web 2.0 allowed speaking of Government 2.0 or participatory government (Baumgarten & Chui, 2009; Bonsón, Torres, Royo, & Flores, 2012; Chun, Shulman, Sandoval, & Hovy, 2010). This stage corresponds to Janowski's third stage "Engagement or Electronic Governance" in his four-stage classification (Janowski, 2015), which the author describes with increased participation and engagement, trust-building and focus on transparency and accountability.

Lachana et al. argue that the use of new disruptive technologies in the public sector moves digital government to a new stage: Government 3.0 (Lachana, Alexopoulos, Loukis, & Charalabidis, 2018). This new stage is characterized by the extensive use of disruptive technologies for the provision of customized services and data-driven evidence-based decision making (Pereira, Charalabidis, et al., 2018). The term "disruptive technology" refers to the technologies, whose application has potential to drastically alter the processes and operations in a particular field of the public sector (Christensen & Raynor, 2003; Kostoff, Boylan, & Simons, 2004). Artificial intelligence (AI), Internet of things (IoT), natural language processing (NLP), Virtual and Augmented reality (VR, AR), big data and block chain are such examples of technologies, as they may lead to significant changes in the way services are produced and consumed both in the private and recently in the public sector (Brennan, Subramaniam, & van Staden, 2019). Disruptive technologies may impact competition and the way performance is measured (Danneels, 2004, p. 249). In the public sector, this also means that citizens' expectations (both technological and organisational) are changing. Recent literature calls this phenomenon 'digital Government 3.0' (Pereira, Charalabidis, et al., 2018), which embodies its own unique challenges. Government 3.0 largely corresponds to the fourth stage of Janowski's classification: "Contextualization or Policy-Driven Electronic Governance", which emphasizes the contextualization of the digital government efforts (Janowski, 2015).

The diffusion of Government 3.0 poses a number of research and training needs to foster success in digital transformation of governments using disruptive technologies. This paper aims to identify and systematize these research and training needs by using an adapted approach of policy-oriented science and technology roadmapping (for an overview see (Wimmer, Codagnone, & Ma, 2007)) paired with the scenario technique (Janssen, Van Der Duin, & Wimmer, 2007). The work was carried out along the Gov 3.0 project (Gov 3.0, 2018a), which is concerned with establishing Government 3.0 as a research domain and with creating a Master curriculum addressing the needs of this new digital government stage. It extends previous work from the Gov 3.0 project on applying the scenario technique (Ronzhyn, Spitzer, & Wimmer, 2019) and on identifying new research and training needs (Ronzhyn, Wimmer, et al., 2019).

The remainder of the paper is as follows: Section 2**Fehler! Verweisquelle konnte nicht gefunden werden.** reviews literaure of digital transformation and the evolutions of digital government towards Government 3.0. Furthermore, different disruptive technologies are briefly summarized to ensure common understanding of these technologies. The science and technology roadmapping methodology for identifying research and training needs on Government 3.0 is described in section 3. It is based on the collection of inputs from experts and students participating in four workshops, where scenario technique was used. Therefore, in subsection 3.2, one scenario is sketched textually and with a poster visualization to exemplify the artefact used in the interaction with experts and students. Section 3.2 summarizes the research needs, while section 0 outlines the training needs identified so far. In section 5, the findings are discussed in view of current research. Finally section 6 concludes with further research.

2. Digital Transformation of the Public Sector

Digitalization emerged as a main driver of human socio-cultural evolution and changing society by increasing connectivity and converting process and information from analog to digital, enhancing communication and interaction between people, organizations and things (Linkov et al., 2018; Loebbecke & Picot, 2015; Scholz et al., 2001). Driven by the technological transformation, new institutional arrangements emerge requiring a change on the roles and competencies to deal with new societal and business models (Hinings, Gegenhuber, & Greenwood, 2018; Loebbecke & Picot, 2015). According to (Hinings et al., 2018), altought being driven by rapid and disruptive changes, digital innovation and digital transformation have an important role in institutional change as a socio-cultural process.

In the public sector, the use of innovative ICTs is an integral part of governments' modernization strategies including digitalization (OECD, 2014). Beyond the generic understanding of this concept as outlined in the introduction, digital government is affiliated with a number of value expectations along this transformation. For example, Lindgren and van Veenstra review the literature and summarize the concept as a combination of organizational change and new digital technologies, creating new forms of governance with three main objectives: deliver public value, improve service delivery and increase government responsiveness and openness (Lindgren & van Veenstra, 2018).

The digitalization in the public sector follows an evolutionary (but not necessarily linear) process of adopting necessary capabilities and models of electronic and smart government, followed by the development of effective smart governance settings and the collaborative environment, which characterizes them (Pereira, Parycek, Falco, & Kleinhans, 2018). According to Janowski, the digital government evolution goes from no governmental transformation, to internal government transformation, transformation that also affects the relationships between government and non-government stakeholders, and finally transformations that depend on the national, local or sectoral government context (Janowski, 2015).

The aforementioned characterizations of digital government help in understanding public sector transformation and its manifold directions. Different authors relate government's digital transformation to a new way of delivering public services through the integration of innovative technologies and through changing needs, which requires a user-driven administration and clear value delivery (Eggers & Bellman, 2016; Mergel, Edelmann, & Haug, 2019). Mahmood and Weerakkody summarize these ultimate goals as better performing government, more satisfied citizens and the restoring of citizens’ trust in governments (Mahmood & Weerakkody, 2016).

In the past decade, society is being reshaped by new and innovative technologies that are envisaged to making the world smarter and more interconnected, embedding services, products and people in broader ecosystems (Scholz et al., 2001). In the public sector, this is expanded towards smart and connected public services (including e.g their related co-design and development), smart decision-making processes, integrated public policies, and new governance structures. Thereby, digital technology, which is defined by Scholz et al as general-purpose technoplogies, including pervasive computing, distributed systems, networks, systems of systems, or the Internet of (Every-) Thing (IoT) (Scholz et al., 2001), is employed.

Taking the above expectations of government's digital transformation and emergence of innovative technologies one step further brings us to Government 3.0. Government 3.0 is a recent evolution, which receives the attention of academia and practice alike. Charalabidis et al review the three generations of electronic (or digital) government and outline Government 3.0 along the following characteristics (Charalabidis, Loukis, Alexopoulos, & Lachana, 2019):

- Main goal: Societal problem-solving, citizen well-being, optimization of resources
- Main method: Smart governance and data-intensive decision- and policy making
- Usual application level: Local to international
- Key tool: Ubiquitous sensors, Smart devices, Applications (Apps), Artificial Intelligence (AI)
- Key ICT area: AI and Internet of Things (IoT)
- Most needed discipline, beyond ICT: Wide variety, depending on the application area.

Given these many facets of Government 3.0, substantial research is needed to better understand

a) how and where these disruptive technologies can be effectively and efficiently employed in government decision-making to create added value,

b) what organizational, legal, governance, socio-cultural and other changes are needed to successfully realize digital transformation and to leverage the benefits of the new technologies in policy-oriented decision-making and in public service provisioning, and
c) what the potential positive and negative impacts and consequences of using the above-mentioned disruptive technologies are, on society and economy as a whole, as well as on individual citizens and employees.

Identifying and systematizing the research needs emerging from Government 3.0 is similarly substantiated by Chun et al, who argue that creating "innovative disruptions" "*requires governments to develop strategies and models for how to use these enabling technologies to achieve a transformation of every aspect of government, such as service provision, decision and policy making, administration, governance and democracy*" (Chun et al., 2010). Innovative disruptions are defined as processes of change which are substantially different from the classical approaches or ways of delivering services or products (Christensen & Raynor, 2003; Kostoff et al., 2004). Effectively exploiting the benefits of new and emerging technologies in the public sector also requires such substantial changes.

In order to identify and systematize the research and training needs to foster success in digital transformation of governments using disruptive technologies that emerged with the diffusion of Government 3.0, we first briefly outline some key disruptive technologies studied in the work of Gov 3.0:

Artificial Intelligence (AI) and Machine Learning (ML): AI refers to capabilities of machines to demonstrate cognitive functions typically associated with human intelligence, usually to solve certain non-trivial problems or make decisions (Russell & Norvig, 2009). Computers use machine and deep learning algorithms to collect information and acquire knowledge to make autonomous decisions. Thus, ML is considered as an enabling technology for AI. Chui et al consider ML as "*the field of study that gives computers the ability to learn without being explicitly programmed*" (Chui et al., 2017). According to Luger, AI and ML are important components of many other technologies like social bots, natural language processing, computer vision, gaming-based simulations and others. Applications in the public sector are e.g. in healthcare, military, finance and economics (Luger, 2005), especially in relation to automatic decision-making, perception and planning (Russell & Norvig, 2009).

Big Data and Data Analytics: Big data is characterized by the three V's: big volume, velocity and variety of data (Laney, 2001). Big data can help governments improve their efficiency, effectiveness and transparency (Milakovich, 2012) by e.g. enabling better and more informed decision- and policy-making (Janssen & Kuk, 2016) through analysis of available data, faster and richer images of evolving reality, and improved services based on better insight into citizen demands and needs (Chen & Hsieh, 2014).

Augmented and Virtual Reality (AR and VR): Virtual reality is a simulation, in which computer graphics are used to create a dynamic realistic-looking world, which a user can interact with by using certain input methods (Burdea & Coiffet, 2003). Augmented Reality seamlessly bridges the gap between the real and the virtual by adding virtual elements to the user's view of the reality aiming to enrich it and to provide additional information or features (Lee, 2012). AR and VR are applied to visualize data e.g. in healthcare, urban planning, transportation, policing, surveillance and more effective collaboration between public workers (Bermejo, Huang, Braud, & Hui, 2017; Huang, Hui, & Peylo, 2014). AR has also a great potential for increasing the interactivity of citizen-oriented services, for example to increase engagement of the young generation as a part of gamification of e-participation initiatives (Argo, Prabonno, & Singgi, 2016).

Gamification: Gamification is a technique to enhance "*a service with affordances for gameful experiences in order to support users' overall value creation*" (Huotari & Hamari, 2017). In the public sector, it is applied to leverage the motivational potential of games and game-play in order to promote participation, engagement, persistence and achievement (Hassan, 2017; Richter, Raban, & Rafaeli, 2015), e.g. in education, democratic engagement or healthcare (Kim & Werbach, 2016), or to influence citizen behaviour to tackle smart city concerns (Schouten et al., 2017; Kazhamiakin et al., 2016).

Simulation and Policy Modelling: Policy Modelling refers to the use of different theories and quantitative or qualitative models "*to analytically evaluate the past (causes) and future (effects) of any policy on society, anywhere and anytime*" (Ruiz Estrada, 2011). Therewith, simulation models are generated to explain causal effects on behaviour, circumstances and influence factors on (public) policies. Policy modelling and simulation techniques can be used on micro or macro level, or to simulate and understand social behaviour (Majstorovic, Wimmer, Lay-Yee, Davis, & Ahrweiler, 2015). Therefore, better informed decision- and policy-making is supported.

Internet of things (IoT): IoT refers to the "*interconnection of sensing and actuating devices providing the ability to share information across platforms through a unified framework, developing a common operating picture for enabling innovative applications*" (Gubbi, Buyya, Marusic, & Palaniswami, 2013, p. 4). IoT is often used as a supporting technology which aids in the realisation of smart city and smart healthcare paradigms.

The different technologies outlined above are not to be considered in isolation in the subsequent work; in fact, some of these technologies substantially increase their potential in the combination of different disruptive technologies. The scenarios developed in the Gov 3.0 project (see an overview in the next section) demonstrate such combinations.

3. Methodological foundations

To identify research and training needs for digital transformation in the context of Government 3.0, we applied an adapted approach of policy-oriented science and technology roadmapping, which was customized over the years to develop a) a research roadmap for e-government (Codagnone & Wimmer, 2007), b) ICT-enabled governance and policy modelling (Bicking & Wimmer, 2011), c) to define the grand challenges of ICT-enabled public policy-making and governance (Majstorovic & Wimmer, 2014), or d) to spot the research and implementation requirements to successfully implement the once-only principle[1].

[1] SCOOP4C, see https://www.scoop4c.eu/index.php/node/527 (last access: 10th February 2020)

3.1. Research approach for the study

The overall approach for identifying research and training needs on Government 3.0 consists of four steps, which we applied in a similar way to the work at hand (see Figure 1):

i) review of the current status of research/development;
ii) scenario development to depict potential future applications;
iii) analysis of the research and implementation needs / gap analysis; and
iv) development of a roadmap / spotting key research needs.

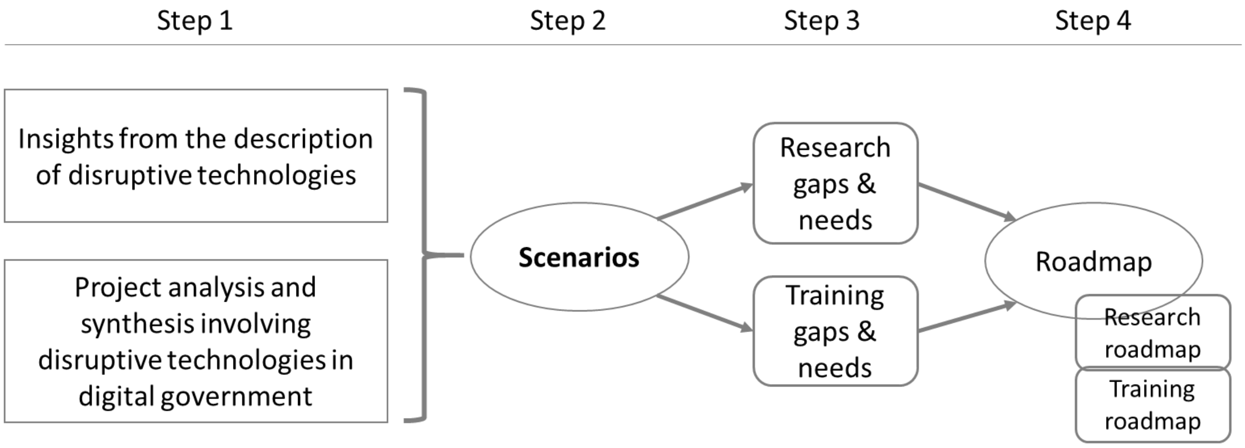

Figure 1: Research design to investigate research and training needs on Government 3.0

The **first step** was conducted using literature reviews on the use of disruptive technologies in Government 3.0 (1039 articles, see (Gov 3.0, 2018b)) combined with analysis of existing projects (a total of 281 projects, see (Gov 3.0, 2019)). The findings of the status-quo analysis built the foundations for developing future scenarios.

In **step two**, the scenario technique was used. The use of future scenarios is an established method to explore research needs along possible futures in various fields, both public and private (Ratcliffe, 2000; Schwartz, 1996). Scenarios typically describe possible future developments in a specific area (Johnson et al., 2012), detailing the involvement of various stakeholders and interplay between these stakeholders (Carroll, 1999). Scenario technique helps to enligthen a problem from different viewpoints and to better understand possible future evolutions (Janssen, Van Der Duin, Wagenaar, et al., 2007), thus improving decision-making (Ringland, 2002). In contrast to forecasts and prognoses, scenarios depict possible developments with varying degree of probability, rather than identifying the most probable future (Bohensky, Reyers, & Van Jaarsveld, 2006; Peterson, Cumming, & Carpenter, 2003).

The scenario method as used in this research was employed in the following way: First, future scenarios describing the use of a set of disruptive technologies were developed by the research team. In total, thirteen different scenarios were developed (some of them were discussed at more than one workshop, others were evaluated by experts outside the workshops). Scenarios included possible future implementations of AI, ML, NLP, IoT, AR, VR and Blockchain technologies as well as implementations of the broader concepts of smart city, gamification and co-creation of public services (see

Table 1 for an overview of the scenarios developed, including the disruptive technologies embodied in each scenario). To exemplify the scenario technique, subsection 3.2 outlines the scenario "Virtual Reality and Augmented Reality for emergency training".

Table 1. Scenarios developed and used for the analysis, including indications of technologies embodied

Scenario Name	**Short summary of the scenario**	Big Data	Open (Linked) Government	IoT	Smart City	AI/ML	Cloud Computing	NLP	Co-creation	OOP	Service Modules	AR/VR	Gamification	Gaming-based Simulation	Blockchain	eID/ eSignature
Smart City AI-aided emergency monitoring system	AI system is monitoring data and is making automated decisions based on data from sensors and social media	☑		☑	☑	☑	☑	☑								
Intelligent citizen portals connected across Europe using chatbot interface for easy interaction with	Citizens use the chatbot interface to interact with government portals that implement the OOP in cross-border public services (e.g. when moving)					☑		☑		☑	☑					☑
Virtual and Augmented Reality for emergency training	VR and AR are used for emergency training of the employees of public buildings. Virtual environments allow to play scenarios similar to real-life emergencies.											☑	☑			
Open Data lifecycle: maximizing OGD benefits	Leveraging the benefits of OGD along the full Open Data lifecycle		☑						☑						☑	
Digital government through Cloud Computing	Realizing government services via Cloud Computing to improve the quality of service and to cut costs						☑									
Using IoT to monitor soil erosion and degradation	Using sensors (IoT) to collect realtime environment data, analysed through an AI system to provide policy recommendations and action plans	☑		☑		☑	☑									
Gamification in energy consumption	Principles of gamification are used to promote environmental outlooks of the citizens and to decrease the use of energy by individuals and businesses				☑								☑			
Gaming-based simulation and policy modelling	Gaming-based simulation is used to further input for formulating better policies in the domain of policing								☑					☑		
Natural Language Processing in tourism	NLP is used for analysing big data collected in social media and allows to formulate concrete improvements to tourist sector propositions	☑						☑								
Blockchain for vehicle lifecycle management	Blockchain is used to store information about the vehicles to ensure optimal lifecycle management														☑	
Using e-ID and e-Signature for verified health data sharing	Using e-ID and e-Signature technologies to ensure health data ownership and increase its value						☑									☑
Co-creation of APIs using OGD	Reusing Open Government Data through the use of open APIs, co-produced by citizens and businesses		☑				☑		☑							
Community Awareness Platforms for behavioural change	Using OGD, data from sensors and social media data to create a platform for raising citizen awareness about important societal issues	☑	☑	☑			☑				☑					

The scenarios were exposed to experts participating in four workshops, which were organized along thematically relevant scientific events (roadmapping workshop at Samos Summit (Samos, Greece) in July 2018, roadmapping workshop at EGOV-CeDEM-ePart 2018 conference (Krems, Austria) in September 2018, workshop at the NEGZ autumn conference (Berlin, Germany) in November 2018 and workshop with students of public administration sciences (Koblenz, Germany) in February 2020). The experts and students were first invited to provide their views on the consistency and persuasion of the scenarios. Second, they were asked to identify possible research and training needs for successful implementation of the scenario from the perspective of their domain of expertise or from their professional work context.

A total of 70 experts participated in the workshops, among them academics, public officials, government representatives, private sector representatives and students. Experts involved were also rather varied geographically: the majority of participants came from Europe (63 persons from 17 countries); other participants came from the Americas (4), Asia (2) and Australia (1). The diversity among experts allowed gathering varied and original input based on experts' individual backgrounds and experiences. The students from the second German workshop complemented the experts' view with insights from young people who are trained to become public servants (dual education program). Internal evaluation of scenarios involved discussions among the experts from within the Gov 3.0 project, primarily from academic background.

The workshops were also used to conduct **step 3** of the approach. Group discussions along the scenarios (led by group moderators from Gov 3.0 project) were used to elicit research and training needs from the scenarios. As a result of the discussion, experts provided a list of research and training needs along with the assessment of how important or pressing a particular need is (using three colours for priority). The assessment was a result of the expert consensus within a group. For prioritisation, a three-level system was used: green – low importance, yellow – medium importance, and red – high importance. This prioritisation helped in summarizing and prioritizing different needs at the later steps of analysis. More details about the scenario development and the organization of the workshops is available in (Ronzhyn, Spitzer, et al., 2019).

The result of the workshops in step 3 were 62 research needs and 54 training needs identified by the experts and students. Additional notes were taken by workshop moderators along the discussions. Both inputs from the workshops were fed into the **fourth (and final) step** of the approach (together with the insights of steps 1 and 2) **-** the analysis and synthesis to elaborate the roadmaps of research and training in Government 3.0. The 62 (resp. 54) needs have been synthesized and grouped by four researchers of the project team into similar needs and areas of concern. In sum, six research needs and five training needs were extracted, which are desribed in sections 0 and 5. These are fed into the two roadmaps (which is currently ongoing research). For the needs analysis, the researchers employed a method of qualitative content analysis (Flick, 2007; Strauss & Corbin, 1990), finally getting to a proper label for each group of needs.

3.2. Scenario example presented during the workshops

As mentioned above, thirteen scenarios were described textually and with a poster to visualize the story to the workshop experts graphically. In the following, we exemplify the scenario description for "Virtual Reality and Augmented Reality for emergency training" by summarizing the textual description (a more detailed version was presented to the workshop participants). The scenario details a possible use of Virtual and Augmented Reality technologies to facilitate emergency training for public employees. It also embodies IoT and Data Analytics to support rescue staff in emergency.

In a case of emergency, people in public buildings have to be rescued quickly and efficiently. Possible emergencies include e.g. fires, earthquakes, floods, other natural disasters, terrorist attacks. In many EU countries, all employees in public buildings have to participate in mandatory emergency trainings. Those trainings take place at least once a year and the participants learn how to implement first aid measures and how to handle the alarm equipment and fire extinguisher. Additionally, public buildings are required to perform fire drills or evacuation drills. In some cases, the fire brigade and police officers are called in for support.

In the future, public employees are able to translate their learned theoretical knowledge into practice through using virtual reality. The whole public building is displayed in virtual reality simulation, where different crisis scenarios can be played out. While the instructions are currently only theoretical, with the help of virtual reality the employees experience and train the evacuation in a realistic setting. The gamification approach can also help make the simulation more immersive. To achieve a realistic surrounding and higher plausibility, multiple human senses are addressed. The VR glasses display dense smoke in the public buildings and corridors in case of an alarm. Additionally, the sense of smell can be stimulated through artificial fragrances, the sound of the fire, sirens or voices of other people are provided via headphones, while radiant heaters can be used to stimulate the aural and temperature sensation. The employee's behaviour, the interactions between the employees and with other persons who are in the building (e.g. patients) are recorded and analysed by special consultants from the fire and police force. Those specialists then give improvement suggestions to the employees. And they can implement these advises in the next training which takes place twice a year. It is also possible to include situations when something does not go "according to the book", for example if there are missing or injured people. If there is such an emergency in the reality, those who participated in the virtual reality training may react better. They will be calmer because they have already experienced such a situation several times.

Augmented reality in turn is implemented to aid the public employees in case of real emergency situations. The employees wear AR glasses connected to the coordinators from the rescue force. The AR glasses are fitted with a GPS module to determine and transmit the exact position. The GPS data are sent to the coordinators at emergency services; thus, they know the exact position and are able to navigate the employees using a map or a building plan. They can also use external databases to get more information about certain important aspects for managing the situation (e.g. piping, electrical wiring, etc.). Furthermore, the coordinators can receive additional data from sensors placed in different areas of the building (e.g. such sensors may sense heat near a specific exit). This allows the rescue coordinator to determine the fastest and safest way out of the building. More efficient than just voice support, the rescue coordinator sends the exit route to the employee's AR device, which displays the guidance overlaid on top of the reality.

Figure 2 demonstrates the visualization of the poster used in the workshops. On the poster, the arrows represent the exchange of information between the actors, while the boxes show technological enablers that are involved at each of the steps for information processing, e.g. Geographic Information System (GIS) and for information exchange (e.g. encryption). Both artefacts were used to deliberate research and training needs with the experts in the different workshops.

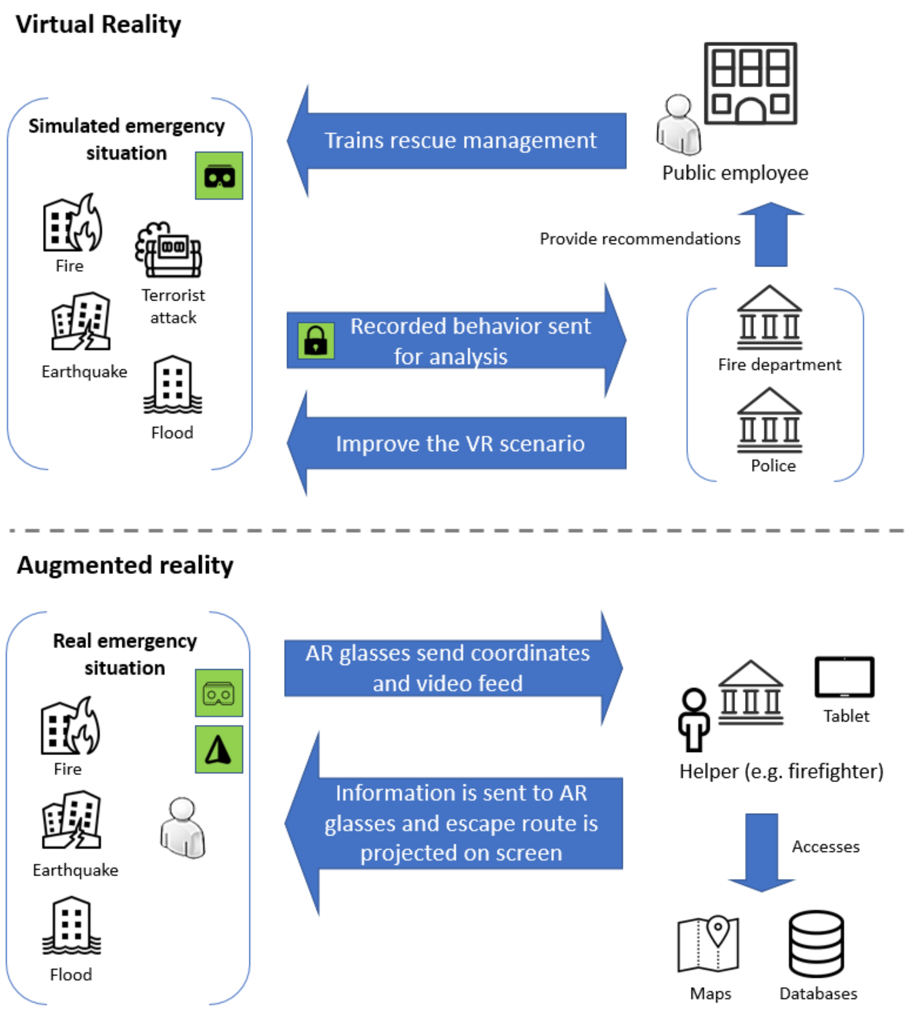

Figure 2. Scenario poster – "Virtual Reality and Augmented Reality for emergency training"

As described in the methodology, the scenario provides an example of possible future implementations of disruptive technologies in public service provision. While most of the relevant technologies can be implemented today, there are still aspects that need to be developed further (e.g. room mapping technology (3D scanning and creation of virtual spaces based on real ones) is still costly to realise). The next two sections outline the main research and training needs (step 4 of the approach) extracted from the thirteen scenarios and informed from the analysis and synthesis in step 3.

4. Research needs on realizing government 3.0

Along the analysis and synthesis of the research, six research needs were extracted in step 4 as listed in column 1 of Table 2. The research needs are outlined in the subsections below.

Table 2: Correspondence of research needs with disruptive technology use in public service

	Disruptive Technologies									Concepts of Government 3.0 using disrupt. t.						
	AI/ML	Big Data	IoT	Gamification	AR/VR	NLP	Blockchain	Cloud (fog) Computing	eID/ eSignature	Smart City	Co-creation	Community Awarenes Platforms	Once-only Principle	Open (Linked) Government Data	Service Modules	Gaming-based Policy Modelling and Simulation
Standardisation and interoperability of disruptive technologies	☑	☑	☑										☑	☑		
Analysis of stakeholders	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
Evaluation and policy making	☑	☑	☑							☑						☑
Data security and data privacy	☑	☑	☑				☑			☑			☑			
Automated decision-making	☑	☑														
Ethical issues	☑	☑	☑													

4.1. Standardisation and Interoperability of disruptive technologies

Further research is necessary on interoperability and standards in order to better lift the potentials for the use of AI in automated decision making, standardisation of collected data by IoT and the standardisation of the IoT devices. Common standards are especially important in IoT as different models of sensors can be used as a network to provide valuable results, so the data collected by these sensors needs to be compatible and interoperable. The successful use of IoT devices is highly dependent of the implementation on effective and interoperable standards (Saleem, Hammoudeh, Raza, Adebisi, & Ande, 2018). In the development and construction of smart cities, standardization of enterprise architecture and requirements for monitoring technical and functional performance has an essential role (Pourzolfaghar, Bastidas, & Helfert, 2019). Another major issue can be seen in the development of IoT security standards. In research, two main gaps can be identified: First the deviation between reviewed standards and IoT security safety, consumer trust, trustworthiness and system integrity. Second, limited information in the adaption, implementation and review rate of government and industry standards for IoT security, which burdens the effectiveness to monitor and evaluate those (Brass, Tanczer, Carr, Elsden, & Blackstock, 2018).

Linked to standardisation, interoperability research needs deal with ensuring that different implementations of the same technology are able to effectively "talk to each other". In this context, the standardisation of intelligent interoperable agents needs to be researched. Such standards address several sectors like economy, industry and service to ensure the interface, compatibility and synergy of their specific applications (Bryndin, 2019). These needs are of high priority in IoT, especially technical interoperability of different sensors (Khan & Kiani, 2012), and in AI/ML applications. Interoperability and standards are likewise key in the implementation of the once-only principle or in the use of big and open (linked) government data.

4.2. Stakeholder analysis and stakeholder engagement

The engagement of stakeholders in the implementation of modern technologies is a fundamental requirement for successful implementation and use of these technologies. Stakeholders are those who affect or are affected by decisions or actions (Freeman, 1984). In the implementation of disruptive technologies, it is necessary to understand who the stakeholders are, how to engage various stakeholders effectively and identify the needs of target groups to involve them adequately in the implementation process. In particular, most of smart city initiatives uncover existing gaps in collaboration, cooperation and coordination account of private and public actors due to diverging interests (Janssen, Luthra, Mangla, Rana, & Dwivedi, 2019). Technologies like Blockchain, AI and Machine Learning have been the biggest research needs in stakeholder (citizen) engagement, co-creation and improvement of the already existing solutions both in public and private sectors. Further research needs include the user studies comparing the use of traditional web search functions and modern solutions such as Chatbots or NLP-based solutions. How far can a Chatbot based on AI and ML take over the functions of traditional web and how can the digital divide between different user groups be overcome in the future, with the use of AI-driven technologies?

Another research need arises as to whether citizen engagement/ co-creation and outsourcing to the private sector could increase the acceptance of and trust towards IoT, AI/ML and other disruptive technologies. Similarly, it is necessary to examine existing architectures of technologies for their suitability in the public sector: in some cases, organizational change and adaptation of government processes is a necessary prerequisite for the effective implementation of systems based on the disruptive technologies.

4.3. Evaluation and Policy making

The assessment of impact and costs of the deployment of disruptive technologies is another research area. It is not yet clear what the real costs are for platforms who realise such technologies, how many technologies are funded and what exercised impact on cities could be determined (Batty, 2016)? The research needs were raised when discussing AI (adapting legislation to the use of cross-border data) and IoT (automated policy making based on IoT data). Further research is necessary to identify the ways to adapt legislation for effective implementation of some technologies in public sector (like surveillance/face identification regulation for AI/ML) and the implications of using AI for the creation of regulations and policy (e.g., exploring the dangers of bias in ML (Baeza-Yates, 2016; Yapo & Weiss, 2018).

The proper way of using simulation and data modelling for digital government services is another research need. Simulation can be used for policy making in different settings and in the design of predictive models. In both cases it may be used as a basis for data-driven decision making. The issues of accuracy of data and accountability need to be addressed when using simulation and data modelling for making decisions. Policy modelling research needs to redirect its focus from disruptive technologies themselves to the outcomes these tools could deliver (Leifman, Fay, Rozenberg, & Nicolas, 2019).

Research in evaluation and policy modelling is often transdisciplinary and also very much dependent on the field, where the concepts are to be used. For different scenarios involving IoT, research should analyse and bring forward successful implementation models as well as a clear understanding of the relevant 'soft' factors e.g. on IoT in urban environments (e.g. when IoT is implemented as a part of a Smart City initiative) or in "earth/water evaluation" (when IoT sensors are used in agriculture). For this reason, analysis of piloting cases can prove a very important step here and allow identifying the criteria for evaluation, build new and adapt existing evaluation frameworks, and identify the benefits and drawbacks of the technology implementations.

4.4. Data security and Data privacy

Data security and data privacy are two important topics for research on the use of disruptive technologies in the public sector. The willingness to allow collection, sharing and the use of sensitive citizen data is contingent on high trust in these technologies and in public administrations deploying them. In particular, the security and privacy of the Blockchain technology needed to be addressed in the context of public services.

Further issues can be identified in Big Data research. The main problems in Big Data security are related to infrastructure problems, privacy issues and data integrity. While implemented private-sector solutions (e.g. in finance) are being used and further developed, the potential for the use of Blockchain in the public sector needs to be researched and evaluated further in the context of digital government (Ølnes, 2016; Yang, Elisa, & Eliot, 2019). Most of the current studies tend to focus on benefits of the technology rather than possible challenges or risks of its implementation (Ølnes, Ubacht, & Janssen, 2017). Privacy and security issues need to be researched in the context of storing sensitive personal data and allowing specific actors the access to these data (Jun, 2018).

Data privacy is a significant issue in IoT as well, especially in urban setting. In case studies (Brous & Janssen, 2015), data privacy and security were found to be the main impediments on the strategic level for the introduction of IoT for digital government. Data accuracy is another issue, which is critical for the implementation of IoT in smart cities. Research needs in data quality are also connected to the standardization issues described in 4.1.

4.5. Automated decision-making

The use of modern technologies and automation mechanisms is indispensable for the public sector. Thus, the possibilities of using disruptive technologies and their possible effects must be investigated. The big data collected by sensors can be automatically processed and analyzed using the AI and ML technologies to provide real-time decisions. Such system may offer significant advantages over "manual" regulation and improve the quality of life in cities (Song, Cai, Chahine, & Li, 2017), yet it poses a number of challenges concerning transparency and accountability and consequently the legal status of such systems. There are also concerns related to adaptability of such systems: as different environments offer different challenges, there might be no one standard way of organizing automated decision-making based on the collected environment data. Further case-study research is necessary to see how AI and ML may be adapted on the local level (Zanella, Bui, Castellani, Vangelista, & Zorzi, 2014). Further challenges in the adoption of such challenges need to be considered, including lack of experts, computational resources, trust and AI interpretability (Al-Mushayt, 2019).

Due to the digitization of the public sector processes, the use of modern technologies and automation mechanisms is indispensable. Thus, the possibilities of using disruptive technologies and their possible effects must be investigated. The big data collected by sensors can be automatically processed and analyzed using the AI and ML technologies to provide real-time decisions. Such systems may offer significant advantages over "manual" regulation and improve the quality of life in cities (Song et al., 2017), yet they pose a number of challenges concerning transparency and accountability and consequently the legal status of such systems. There are also concerns related to adaptability of such systems: as different environments may embody different challenges, there might be no one standard way of organizing automated decision-making, based on the collected environment data. Further case-study research is necessary to see how AI and ML may be adapted on the local level (Zanella et al., 2014). Further challenges in the adoption of such challenges need to be considered, including lack of experts, computational resources, trust and AI interpretability (Al-Mushayt, 2019).

4.6. Ethical issues

A common research need in the discussion of the disruptive technologies is ethics and moral issues. By far, AI is the most ethically controversial technology. Research directions regarding AI include privacy research (surveillance, profiling), ethics of automated decision making (especially concerning sensitive decisions, e.g., in law enforcement and health), issues of responsible research. The consequences of discrepancies between the real world and the data used for AI-based decision making were identified as a high-priority research issue as decisions based on incomplete (or even biased) information may be unfair and problematic (Dameski, 2018). Aligning the values of autonomous AI system designers with the public interest is a major research need, which need to be addressed before such systems are implemented on the large scale. However, ethical and social barriers can be identified in the adoption of AI, and resulted from lacks in citizen trust on machine intelligence and the anxiety on the replacement of employees by machines (Androutsopoulou, Karacapilidis, Loukis, & Charalabidis, 2019).

One of the ethical issues raised in regard to the implementation of IoT is the sustainability of sensors infrastructure; if IoT sensors are used in rural environments, they are much more difficult to control and recycle properly. Possible pollution is an ethical concern that needs to be researched.

(Ronzhyn & Wimmer, 2019) conducted a research on the ethical isues with disruptive technologies, concluding that there is a significant number of ethical issues connected to the implementation of disruptive technologies in public services. In addition, (Alexopoulos et al., 2019) recommend further research in privacy and ethical issues in the collection of personal data and the ownership of such data by machine learning in government services.

5. Training needs

Along the analysis of the scenarios and discussions with the experts and students in the workshops, five training needs were identified in step 4 of the approach as listed in column 1 of Table 3. The table also indicates, for which disruptive technologies the specific capabilities are particularly required. The training needs are outlined in the subsections below.

Table 3: Correspondence of training needs along with disruptive technology use in public service

	Disruptive Technologies									Concepts of Government 3.0 using disrupt. t.						
	AI/ML	Big Data	IoT	Gamification	AR/VR	NLP	Blockchain	Cloud Computing	eID/ eSignature	Smart City	Co-creation	Community Awarenes Platforms	Once-only Principle	Open (Linked) Government Data	Service Modules	Gaming-based Policy Modelling and Simulation
General technology skills	☑		☑		☑		☑	☑	☑							
New technologies in public management & digital government	☑		☑				☑									
Management and economics capabilities on the use of disruptive technologies	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
Capabilities in data science, data security and legal compliance	☑	☑	☑	☑	☑		☑		☑	☑			☑	☑		☑
Capabilities in responsible research and in sustainability	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

5.1. General technology skills

AI and Machine Learning, Blockchain and IoT are the technologies with most technical requirements for using and implementing them in the public sector. When using AI/ML, field experts in multidisciplinary domains are required to have expertise in analysis, modelling and tool use, which requires professional training. Public officials must be able to deal with non-standard situations in requests through digital agents and addressing multiple identities in the system. For the implementation of these technologies, skills on app development, security encryption and access rights are fundamental. For implementing blockchain technical training of identity providers, employers, public sector and social workers is necessary, as well as understanding the impact of decentralized distributed systems on current administrative processes. Public officials' training on the use of specific devices are important for the use of VR/AR equipment and IoT sensors. Implementing IoT also requires skills on decision system modelling, monitoring systems and cloud (fog) computing/infrastructure.

5.2. New Technologies in Public Management & Digital Government

Training on public management and digital government is important for applying most of the discussed disruptive technologies. For government employees using AI/ML, Blockchain and IoT, skills on new technical components (IT systems) and new legal basis are required, as well as the ability to establish a framework for cooperation with private companies. For blockchain, including a basic training for public sector specialists on the technology use in government is required. When using IoT in government applications, training needs refer to introductory topics of digital government such as enterprise architecture, public administration and public sector innovation, as well as the emergent digital transformation domain, which refers to completely redesigning government services to fulfil changing user needs (Mergel, Kattel, Lember, & McBride, 2018).

In addition to the major training needs of this area, our research indicates the lack of knowledge mainly for the public officials and citizens regarding acceptance of disruptive technologies such as AI and blockchain. A "train the trainers" approach seems to be an efficient means to cover this need.

5.3. Management and economics capabilities on the use of disruptive technologies

Considering that digital transformation affects citizens, business and the public sector and requires organizational change and new digital technologies, management training is found to be relevant for applying any of the disruptive technologies in the public sector. Considering AI/ML applications, relevant aspects include the ability to involve citizens in the process, as well as knowledge management and business models of social work (social innovation). Training on process/change management is important for using VR/AR as well as eID and eSignature in government. Similarly, blockchain, cloud computing or IoT applications require training for public employees on project management, entrepreneurship, doing business and cost-benefit analysis. Likewise, these capabilities are of high importance in different concepts of Government 3.0 that employ disruptive technologies in order to leverage the benefits of these technologies in the specific contexts and to reduce potential risks.

5.4. Capabilities in data science, data security and legal compliance

Most of the training needs concerning data science and security are connected to the implementation and use of the AI, ML and IoT technologies. It is worth mentioning that these technologies have been used in different scenarios. Our results reveal a lack of knowledge on data analysis and artificial intelligence tools, the ways of achieving trust and data security including accuracy of the IoT devices and user input for the target groups of civil servants, professionals and citizens. Legal competencies are identified as a very important training need for all target groups including researchers, especially concerning the blockchain and AI technologies.

5.5. Capabilities in responsible research and in sustainability

When disruptive technologies are employed, responsible research and sustainability of the applied solutions are further crucial capabilities needed. In regard to AI, a need to train the researchers in ethics was identified, specifically concerning the ethical solutions to the problems of automated decision-making. For public servants, the focus is on the managerial training needs: sustainability assessment of the applied solutions (IoT) in the public sector understanding what technology should be applied, if this technology is covering the current needs, and especially on sustaining the sensors infrastructure. Energy consumption and environmental sustainability have also been identified by Kankanhalli, Charalabidis, & Mellouli (2019) amongst the main challenges for IoT-enabled AI applications to provide benefits to public governance and citizens' life.

6. Discussion

Several of the research needs discussed in section 0 have already been mentioned by researchers of the specific technologies in individual publications: for IoT in public services, interoperability and standardisation is seen as major issue (Ahlgren, Hidell, & Ngai, 2016). In the AI research, ethics has been a steady concern (Dameski, 2018) and privacy is a huge pressing issue in ICT generally (Smith, Dinev, & Xu, 2011), especially with the implementation of the once-only principle. The above research needs were highlighted in the context of disruptive technologies in public service representing an overview of current demands for research and innovation, along Government 3.0 evolutions. This overview aims to stimulate the discussion and help to further advance the digital government research and practice. While the research needs in this paper reflect the results from the Gov 3.0 project and its interaction with 70 students and experts along four workshops, the digital government community is invited to expand and complement the findings. In particular, the research needs demonstrate avenues for innovative PhD research to perform extensive literature review and develop case studies or expand existing theories and concepts to successfully implement disruptive technologies in innovative public service provisioning in the future.

The analysis of training needs reveals two types of training that are needed. For the academics and professionals who are going to conceptualize new services and concepts, where disruptive technologies are used, training in the technology is necessary: both general training regarding data security, privacy and sustainability, and specific training on particular technologies. At the same time, for public officials, soft and managerial skills are particularly important for ensuring citizen trust towards the use of disruptive technologies and concepts of Government 3.0. Services based on these technologies are significantly different from the ones of traditional digitalization attempts and acceptance of the new services by the public and by the businesses is a critical issue. In this regard, training the trainers (public officials, administrators) is a critical need so that stakeholders are able to use the new technologies and explain the benefits and functionality to the public. Outlining these training needs along the Gov 3.0 project serves as a trigger to reflect and embody knowledge and skills on the use of disruptive technologies in the education and training programs of higher education institutions and professional training offerers, targeting professionals and students.

Involving experts and students in the discussion of new technologies in public services is very important. The chosen scenario-based technique has shown good results in stimulating the discussion and gathering diverse insights on disruptive technologies in digital government. Still, the workshop-based scenario approach has some limitations that need to be acknowledged: First, the competence area of an expert (and level of education a student brings in) has an effect on the type of suggested needs. Experts from public service tend to view problems from the perspective of a government employee, while people with background in informatics are more interested in issues connected to the technical realisation and data. This means that if a particular discussion group at the workshop lacked experts from the scenario's field, the importance of some of the research and training needs was conceivably underestimated. Policy makers and representatives of the NGOs/public institutions (largely absent from the workshops) could also provide a unique vantage point and new useful needs. Further research would require involvement of experts from these areas. Similarly, the geographic scope should be expanded, as there were some differences between the input from public sector representatives from different regions of the world: e.g., more focus on the people-related issues from countries where digital government is less developed. Such differences and viewpoints need to be examined further by involving a more diverse range of experts as well as more people representatives.

Finally, it should be mentioned that, while in the Gov 3.0 project research and training needs have been identified, the dialogue with the experts and students does not produce 'ready' research and trainings. The project team needed to refine the participants' contributions and to draw powerful conclusions after the workshops. An iterative step of validation of the resarch findings involving the experts and students that contributed in the workshops would add rigor to the research method.

7. Conclusions

In this paper, six overarching research and five training needs were identified and systematized for the wide and successful implementation of Government 3.0. The research was developed using an adapted approach of policy-oriented science and technology roadmapping, with a review of the state of the art of research and implementation in digital transformation and the use of disruptive technologies in public service provisioning. Subsequently, thirteen future scenarios were developed from the insights from the literature review and analysis of existing projects, which were then exposed to a critical validation and discussion to identify research and training needs regarding internet of things, artificial intelligence, virtual and augmented reality, big data and other disruptive technologies to be deployed in newly emerging concepts of Government 3.0 such as smart city, once-only principle implementations, policy modelling and simulation, co-creation, etc. 70 experts and students reviewed these 13 future scenarios and spotted 62 research and 54 training needs on Government 3.0 and disruptive technologies. These research and training needs were subsequently consolidated and validated among the authors in iterative steps to receive the above six research and five training needs.

As stated in the Introduction, this paper does not aim to provide an exhaustive list of research and trainings needs. Instead, the goal is to specify a starting point for a broader and more informed discussion about how such new (disruptive) technologies can be successfully deployed in the public sector, therefore leveraging the benefits of these technologies in digital government while at the same time constraining the drawbacks affiliated with them. Fifteen examples of the latter have been elicited as unintended consequences of disruptive technologies in digital government, such as digital divide (particularly regarding vulnerable groups) and digital illiteracy, lack of government capacity, social media jeopardizing democracy, data as the new currency and the bias on data-driven decision making, etc. (Pereira et al., 2020; Scholz et al., 2001). The research and training needs outlined in this paper aim to create awareness that the diffusion of disruptive technologies has a wide impact on the way government and its constituency will interact in the future and how societies' cultures and behaviour will potentially change. Such dramatic impact needs profound research and professionals that are capable of estimating these potential impacts.

In the Gov 3.0 project, the research and training needs will be further consolidated into recommendations regarding the implementation of disruptive technologies in public service. The insight gained through the scenario-based workshops and described in this paper will be used further within the Gov 3.0 project (Gov 3.0, 2018a). First, in the elaboration of the Government 3.0 research roadmap and, secondly, for the development of the joint Master curriculum, addressing the identified training needs.

As already indicated in the previous section, the findings presented in this paper invite scholars and PhD students to extend the research and deepen findings through extensive literature review and case study research to add theorectical and conceptual contributions as well as to expand the practical experiences with the use of disruptive technologies along digital transformation.

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About the Authors

Maria A. Wimmer

Maria A. Wimmer is Full Professor for E-Government at the Computer Science Faculty, University of Koblenz-Landau, Germany (since 2005) and founding member of the National E-Governmen Competence Center (NEGZ), Germany. She received her Dr. techn. in Computer Science from Johannes Kepler University in Linz, Austria (2000) and her Dr. habil. in Applied Computer Science from the same University (2003). Maria focuses on digitalization and digital transformation of the public sector since two decades. Her research is driven by a holistic view on designing innovative solutions for digital public services. Focus is on interoperability and stakeholder engagement when leveraging innovative new technologies for public service. Maria has been involved in a number of EC-funded and regional projects. Current projects address the once-only principle implementation (TOOP, SCOOP4C, BKS-Portal.rlp), the introduction of disruptive technologies (Gov 3.0, SWiA, Smart Winery), interoperability (iFLOAT) and stakeholder engagement. She co-authored over 170 peer-reviewed articles and is a member of the jury for the annual German digital government awards. More information about her is available here: http://www.uni-koblenz.de/agvinf/

Gabriela Viale Pereira

Gabriela Viale Pereira is Assistant Professor for Information Systems at the Department for E-Governance and Administration at Danube University Krems and Research Fellow at CTG UAlbany. She holds a Post-Doctoral Degree from the Center for Research on Public Administration and Government at Getulio Vargas Foundation (FGV), Brazil (2019) and a Doctoral Degree in Administration from the School of Business at Pontifical Catholic University of Rio Grande do Sul, Brazil (2016). She is Project Coordinator of the Erasmus+ Strengthening Governance Capacity for Smart Sustainable Cities (CAP4CITY) project. Gabriela's activities include research in electronic government and ICT-related Governance projects involving smart governance, smart cities, open data, data analytics and government 3.0. Gabriela has authored and co-authored more than 40 peer-reviewed publications on Information Systems and e-government. In addition, she has been working with a variety of organizations such as United Nations, ITU, and Council of Europe and she is a Board Member of the Digital Government Society (2020/2021).

Alexander Ronzhyn

Alexander Ronzhyn is a researcher and lecturer at the E-Government research group at University of Koblenz-Landau and researcher at the National E-Government Competence Centre in Germany. He holds a doctoral degree in Sociology and has been involved in research on both national and international levels. Alexander is most interested in studying the intersection of ICT and society, examining how technologies change the dynamics of the social systems. He published papers on social media and society, digital activism, digital government, ethics, smart cities and government 3.0.

Vera Spitzer

Vera Spitzer is a research assistant and PhD student at the E-Government research group, University of Koblenz-Landau, Germany. In her dissertation, Vera focuses on the factors influencing the implementation of e-government in Germany. She co-authored papers in the context of digital transformation in cross-border organizations and government 3.0. Furthermore, she is involved in the projects SWiA and Smart Winery with the administrative district Cochem-Zell, where disruptive technologies and co-creation are applied in public service.

