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The Three Generations of Electronic Government: From Service Provision to Open Data and to Policy Analytics

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Abstract. For long time research and practice in the area of Electronic Government (e-government) has been focusing on the use of information and communication technologies (ICT) for improving the efficiency government agencies' internal operations, as well as transactions with citizens and firms. However, the increased needs and expectations of citizens, and the proliferation of 'participatory democracy' ideas, gave rise to a new generation of ICT exploitation by government for increasing and enhancing citizens' participation. Furthermore, the increasing social problems and challenges that had to be addressed by government through appropriate public policies, such as the increasing inequalities and poverty, the aging society, the environmental degradation, and the rising number of 'unpredictable' events, such as the financial and economic crisis, give rise to the development of a new wave of e-government focusing on policy analytics for supporting the design of effective responses - public policies for these challenges. Therefore, evolutions in the needs of modern societies, in combination with technological evolutions, give rise to evolutions in e-government, and the emergence of new generations of it. This paper aims at the identification and better understanding of the main characteristics of the different e-Government generations, using an analytical framework based on two rounds of literature review. The results of the study provide insights on the main features of the three main e-government generations, regarding their main goals, obstacles, key methods and tools, and reveal the new emerging generation of e-Government 3.0 and its basic characteristics. Furthermore, within the first and to some extent the second e-Government generation there have been substantial advancements, which have created distinct sub-generations of them, revealed and analysed through extensive relevant growth/maturity stages research.

Keywords: Electronic Government, (e-)Government 1.0, (e-)Government 2.0, (e-)Government 3.0, e-Government generations

1 Introduction

The objective of Electronic Government (e-Government) research and practice has been the exploitation of ICT in government, and the provision of ICT-based services to

public servants, citizens and firms, aiming initially at efficiency and effectiveness improvements of government agencies' internal operations, as well as transactions with citizens and firms, and then at citizens' participation as well as transparency increase and enhancement. As the expectations and needs of citizens and societies in general are changing and growing, and also the capabilities offered by ICTs are evolving, we observe a shift in e-Government focus, leading to an evolution of e-Government. The evolution of e-Government is influenced on one hand by its wider external environment (such as economic, political and social), and on the other by its technological environment. In all these evolutions there is a common pattern: initially existing practices, processes and services are automated/supported through ICT, and then they are subjected of incremental ICT-based improvements or innovations that governments tend to adopt, by transforming the already existing practices, processes and services, or by adopting new ones [1].

These evolutions have generated several e-Government waves, which have been shaped by societies' problems and needs in combination them with technological developments. A first wave of e-government services was meant initially to exploit ICT in order to improve internal efficiency of government agencies, by automating or supporting their complex internal processes, and then to take advantage of the high penetration and use of the Internet in order to establish electronic transaction with citizens and firms through the web, by developing public e-services for them. This wave was aiming initially at the automation and support of public services, and then at the transformation of them, addressing issues of efficiency and effectiveness related to the public services provision. The proliferation of the 'participatory democracy' ideas in combination with the high penetration and use of the Internet gave rise to second wave of e-Government services for citizens and firms, which go beyond the support and enhancement of transaction with them, aiming at the support and enhancement of the relationship and communication of government with them. This second wave of e-Government attempts to utilize the power of the Internet, and later the social media, for establishing a more close and stronger interaction and collaboration with the society way. More participatory Internet-based services and capabilities were offered to citizens in order to be engaged and participate more in the policy making process. This wave is also associated with enhanced transparency and accountability through the development of services that open to the society important government data.

This succession of different waves/generations of e-government has changed perceptions about the content of e-government and has resulted in several definitions that have been formulated through years in order to describe e-government, as the notion is evolving, focusing on different characteristics of the emerging generations of it (e.g. [2-6]). Because of this, although there is an enormous frequency of use of the term "e-government", there is still not a clear and consistent understanding of the content of this concept among practitioners and academia. However, despite the fundamental importance of this evolution of the e-government domain for the society and the economy, limited systematic research of it has been conducted.

The current study aims to contribute to filling this research gap; its specific research objectives are:

- (i) to establish a common understanding of different e-government developments' categorization into specific e-government generations;
- (ii) to provide integrated definitions for the different e-government generations and identify the main characteristics of them;
- (iii) to understand internal evolutions within each of these e-government generations, and possibly identify sub-generations of them;
- (iv) to develop an analysis framework for the above, setting up the analysis perspectives in the form of research questions towards the systematic investigation of e-government generations, which can be of wider usefulness for future research on this topic.

The rest of this paper is organized as follows. Section 2 provides background information on associated domains that illustrate similar evolution paths and should be considered in the analysis. Section 3 describes our methodological approach, while sections 4 to 6 present the results of our research. Finally, section 7 includes conclusions and suggestions for further research on this topic.

2 Background

With the ICT constituting key enablers for the evolution and even the disruption of most sectors [7], including the government one (through the development of e-government), completely new opportunities for the societies, the private and the public sector, are being created for exploiting ICT for addressing complex problems and challenges, and for facilitating economic growth. Technological advances have driven dramatic transformations and evolutions in many domains and have led to the emergence of new generations of them. In the domains of the electronic content publishing [8][9], and also the industry [10][11], where we can observe evolution paths which are most probably closely related to the e-government one, we observe the emergence of different generations of them: Web 1.0, Web 2.0 and Web 3.0, and also Industry "1.0", "2.0", "3.0" and occasionally "4.0".

2.1 The evolution of the Web

In the area of electronic content publishing we can distinguish different generations of the web, driven by technological evolutions [8][9]. In Web 1.0, applications were generally aimed at publishing mainly 'read-only' content, to be 'consumed' by users, but allowing limited interaction with it. Subsequently, Web 2.0 has been the term used to describe a new generation of the web, allowing more interaction with already published, development of 'user-generated' content, transforming passive content consumers to more active content 'prosumers' (producers and consumers), and also development of networks for content dissemination. The most recent generation, Web 3.0, is about a 'semantic' web of data, which through the semantic annotation of its data provided enhanced data search and link capabilities, allowing this web of data to interface better with itself, and also to feed data to other web applications being used by people around the internet. Web 3.0 technologies are the response to the ever-increasing amounts of data generated by the users and organizations, which have to be searched and exploited more efficiently. Furthermore, as no single platform will be able to handle such

amounts of data, the necessity arises for the decentralization of the relevant services, which is reflected in the emergence of technologies like distributed computing or block-chain.

2.2 The evolution of the Industry

Similarly, in industry we can distinguish some distinct generations of it, driven by technological evolutions [10][11]. Industry 1.0 introduced the concept of mechanical mass production, by using water- and steam-powered machines, while Industry 2.0 utilized the power of electricity, and at the same time it developed new methods for increasing the efficiency and effectiveness of manufacturing facilities, through the improved allocation of various manufacturing resources. Industry 3.0, also known as the third industrial revolution, was based on the development of electronic hardware and software, which was used for improving planning of industrial operations, as well as extending automation of previously manual production tasks; also, these offered new services and capabilities based on optimizing warehouses management, which are completely beyond the realm of inventory control and shipping logistics. Recently Industry 4.0 has emerged, which refers to the advanced digitalization and use of the ‘Internet of Things’, big data and analytics technologies within factories, in order to generate new production-related information, which can be used for increasing further production efficiency (production process innovations), and also for the development of novel products and services (product and process innovations). Among the core characteristics of Industry 4.0 are: quicker decision-making, decentralization, and products/services customization and personalization, with the use of big data as an important factor driving industry 4.0.

3 Methodology

The main research objective of this study is the identification and better understanding of the different generations of e-Government. In order to define to the necessary elements/perspectives of each generation to be examined and analysed we developed an analysis framework, based on the method for the analysis and development of science base in a domain proposed in [12], which has been adapted to the needs of this study. Each identified analysis element/perspective was converted into a research question. The final analysis framework we constructed in this way is shown in Table 1, which presents the different analysis perspectives we used to investigate the major characteristics of each e-government generation, along with the corresponding research questions and their detailed explanations.

Table 1: Analysis Framework: Main Perspectives, Research Questions, Explanations

#	Main Perspective	Research Question	Explanations
1	Main Goal	What is every generation aiming to achieve?	The result/objective that each generation of eGovernment aims to achieve.

2	Main Method	How can their goal(s) be achieved?	An established, prescribed, or logical, practice or systematic process of achieving the main goal with accuracy and efficiency based on a credible approach.
3	Usual Application Level	Which is the targeted government level?	Related environment of offered services
4	Key Tools	Technological tools for accomplishing their goal(s)?	Main technological tools used for accomplishing/achieving the main goal.
5	Key Obstacles/Risks	Are there any obstacles/risks?	Determining factors capable of preventing the main goal to be achieved. Could be a policy or the users' resistance to change.
6	Key ICT Areas	Which technologies are being used?	Key enabling technologies allowing the deployment of the main method and the development of the key tool.
7	Most Needed Discipline, beyond ICT	Which are the important scientific discipline(s) to be leveraged beyond ICT?	Identification of the most important scientific discipline(s), beyond ICT, for the achievement of the major goal of each generation.

As a second step, we proceeded with the identification of the main literature that contains the available definitions for the different generations of e-government. From a preliminary search we found that previous e-government literature distinguished three main generations of e-Government, referred to as “e-Government 1.0”, “e-Government 2.0” and “e-Government 3.0”, or even using the terms “Government 1.0”, “Government 2.0”, and “Government 3.0”. So we searched the EGRL (V. 13.5, is renamed DGRL - Digital Government Reference Library) and Google Scholar using the above terms as keywords, as well as “eGovernment definition”, in order to find publications enabling us to answer the above seven fundamental research questions of our analysis framework (see above Table 1). We found 17 papers in total, which however did not include sufficiently detailed information for providing all the necessary answers to the above seven research questions, but provided us more detailed keywords for conducting a second round of more extended literature search. In this second round, in addition to the previously used EGRL (V. 13.5), we extended our search to the Scopus library and Google Scholar. We found 126 papers, from which initially we examined their abstracts, in order to select the most appropriate ones for answering the above research questions. Finally, 35 papers were selected as more relevant to be thoroughly analysed.

As a last step, based on these papers we proceeded to the description of the above mentioned seven main perspectives of each e-government generation. The results are presented in the following section 5, enabling a better in-depth understanding of the characteristics of the different generations of e-government.

4 The Three Generations of e-Government

In Table 2 we can see the key findings concerning the abovementioned seven main perspectives/questions of the three e-government generations, as well as their supporting literature. A main similarity identified concerns the perspective/question 5 of ‘key obstacles/risks’: the same main obstacle has been identified for all three generations of e-government, which is emphasized in all relevant papers: public sector mentality, which does not favour risk taking and innovation. Public servants and politicians seem to be reluctant to be early adopters of new technological advancements in order to achieve the main goal of each generation.

Table 2: Generations of Digital Government

#		e-GOV 1.0	e-GOV 2.0	e-GOV 3.0
1	Main Goal	Better Services [13][14][15][16]	Openness & Collaboration [13] [17][18][19][20][21]	Societal problem-solving citizen well-being, optimization of resources [22][23]
2	Main Method	Interoperability for Connected Governance [14][24][25]	Open & Collaborative Governance [17][18][19][20][21]	Smart Governance & data-intensive decision-policy making [22] [23] [26]
3	Usual Application Level	National [13][25]	National & Local [17][18]	Local to International [27]
4	Key Tool	Portal [16][18][28]	Social Media [13][17][19][20][21]	Ubiquitous Sensors/Smart Devices/ Apps/AI [29] [30]
5	Key Obstacles/ Risk	Public Sector Mentality [20][25][31]	Public Sector Mentality [17] [27][31]	Public Sector Mentality [27]
6	Key ICT Area	Organizational Infrastructures [15][20]	Social Media & Open and Big Data [17][19][20] [25]	Artificial Intelligence & IoT [22] [23]
7	Most Needed Discipline, beyond ICT	Management [14][25][31][32]	Social and Political Sciences [20] [21]	A wide variety of disciplines concerning the domains of government activity, such as economic, environmental, behavioural sciences [33]

With the only exception of this perspective/question 5 concerning the obstacles/risks remarkable differences have been identified between the three generations in all the other examined perspective/questions. For perspective/question 1 about the main goal of each generation we can conclude there is a shift in the main goal/scope in e-government through the years. While e-Government 1.0 pursues the provision of better transactional services by the public sector for the businesses and the citizens [13][14][15][16], e-Government 2.0 offers capabilities towards increasing citizens’ participation, as well as openness and accountability of governments

[13][17][18][19][20][21], and thus enhancing the quality of democracy. Finally, e-Government 3.0 comes as the logical response on one hand to the growing problems and challenges that modern societies have to be managed through effective government policies, and on the other hand to the deluge of data produced from the second generation of e-government (mainly large quantities of textual data from various social media sources), as well from new technologies (sensors, Internet of Things (IoT), etc.); it is aiming to exploit these data for providing support to policy-making, societal problem solving, as well as citizens' well-being (e.g. for citizen-level decision support services i.e. find the quickest route to your destination by-passing high traffic areas) and data-intensive decision making (policy informatics) [22] [23].

In order to achieve these goals in e-Government 1.0 the most common methods and tools are interoperability between IS of government agencies, as well as towards central electronic 'one-stop shops' and national portals [14][24][25]. In e-Government 2.0 social media [13][17][19][20][21] play an important role for the development of new governance models, characterised by more participation of and collaboration with the society (individual citizens, communities, stakeholder groups, firms, professional and business associations), with the most advanced governments to adopt this new way of communication with the citizens, as well as citizens' participation to governmental decisions [17][18][19][20][21]. Moreover, e-Government 2.0 emphasises the opening and release of government data by developing national and local open government data portals, in order to promote transparency [17][18]. In e-Government 3.0 the increased use of sensors and smart devices producing big data [23], ranging from human text to sensor data, combined with advanced analytics and modelling, which increasingly make use of highly sophisticated AI techniques, and possibly ubiquitous services (i.e. cloud) [29] [30], allowing data-intensive and evidence-based decision and policy making [22][23] [26].

The key ICT area of e-Government 1.0 is organizational ICT infrastructures [15][20], while for e-Government 2.0 it is social media for citizens involvement, and open and big data [17][19][20][25], while for e-Government 3.0 it is analytics, modelling, artificial intelligence and Internet of Things. Finally, in order for all the above to be achieved the most needed 'complementary' discipline, beyond ICT, is management for e-Government 1.0 [14][15][31][32], social and political sciences for e-Government 2.0 [20] [21], and a wide variety of disciplines for e-Government 3.0, concerning the multiple domains of government activity, such as economic, environmental and behavioural sciences [33].

From studying in detail the above literature, it can be concluded that e-Government 1.0 focuses on the delivery of informational and transactional services, as well as on their production through government agencies' internal processes, being based on static ICTs and Web 1.0. On the contrary e-Government 2.0 focuses on the delivery of consultation, participation and open data services, and uses the concepts of Web 2.0 in combination with various social media management tools and technologies, as well as textual data analysis techniques; it aims at improving the openness and transparency of government, and at the same time collecting useful information and knowledge from the citizens about social problems and challenges, as well as ideas and proposals for

managing them, applying crowdsourcing ideas in government, which lead to the development of the 'citizen-sourcing' [34][35][36]. The emerging new generation of e-Government 3.0 focuses on supporting and enhancing higher level policy-making functions of government, and for this purpose it exploits e-Government's 1.0 and e-Government's 2.0 technologies, and also some emerging innovative technologies, such as big data, analytics, AI and IoT [30][33].

Taking into account the above literature we can provide the following definitions of these three e-Government generations:

- e-Government 1.0 refers to the utilization of ICTs and web-based technologies for improving or enhancing the efficiency and effectiveness of public service production and delivery to citizens and firms; therefore, it includes both government agencies' internal intra-organizational information systems (IS) for improving the efficiency of their internal operations and processes, and also Internet-based IS enabling electronic transactions of citizens and firms with government agencies.

- e-Government 2.0 refers to the use of the collaborative tools and approaches of Web 2.0, as well as to the opening of public information, in order to achieve more open, accountable and responsive government, and promote government transparency, and citizens' participation and collaboration.

- e-Government 3.0 refers to the use of new disruptive ICTs (such as big data, IoT, analytics, machine learning, AI), in combination with established ICTs (such as distributed technologies for data storage and service delivery), and taking advantage of the wisdom of crowd (crowd/citizen-sourcing and value co-creation), for supporting data-driven and evidence-based decision and policy making.

Furthermore, it is worth mentioning that in both the first two generations the reviewed relevant literature distinguishes two distinct stages: the first is oriented towards the support of existing practices, processes and services of government agencies, while the second is oriented towards the ICT-based transformation of them [1]. We expect something similar to happen with the third generation as well. In general ICT, though not immediately but after some time required for learning, seems to transform the way public administrations operate and interact with citizens and businesses, offering valuable new capabilities.

5 E-Government 3.0

Since e-Government 3.0 is the latest generation of e-Government, there is limited literature about it, so it is worth analysing further its main characteristics:

- It constitutes a major advancement of e-Government, strongly differentiated from the previous two generations, with respect to both objectives (to support higher government agencies' functions: high-level decision-making as well as policy-making), and technologies used (established ICTs, in combination with high sophisticated new disruptive ICTs, such as big data, IoT, analytics, machine learning, AI, blockchain, etc.).

- It is motivated and driven by both social factors (increasing intensity and complexity of social problems and challenges) and technological factors (the need to utilize the

above disruptive ICT in order to exploit and extract value from the large amounts of data collected and possessed by government).

- One of its main directions is the exploitation of the IoT by government agencies. The use of a sensors on physical devices, vehicles, infrastructures allows the collection of large quantities of data that enable the provision of valuable services to citizens, firms as well as public servants. A large-scale use of IoT enables in the context of modern cities addressing the big challenges created by their continuing growth, and improving citizens' quality of life, through the development of smart cities [30].

- The availability of vast amounts of data in government agencies enables the use of AI and machine learning for constructing useful models that support and enhance decision and policy making.

- Movement towards decentralization: the necessity to deal with vast amounts of data efficiently (once only principle) and securely (principle of trustworthiness and security) warrant the use of distributed technologies like blockchain, which are expected to be widely used for government services [37].

It is also worth mentioning that the term “e-Government 3.0” has been first used by South Korea in order to describe its efforts mainly within its ‘Open Government Partnership’ [38]. It involves four main commitments: (i) to increase the availability of information about governmental activities; (ii) to support civic participation; (iii) to implement the highest standards of professional integrity throughout our administrations; and (iv) to increase access to new technologies for openness and accountability. So, we remark that the main elements of this South Korean definition of “e-Government 3.0” are actually the ones included in the existing definitions of “e-Government 2.0”.

6 E-Government Generations' Elaboration: Sub-generations

If we elaborate further the identified three e-Government generations, we can distinguish distinct sub-generations in the first two of them. In particular, within e-Government 1.0 and 2.0 generations there have been substantial advancements, which have created distinct sub-generations of them that have been revealed and investigated through extensive relevant growth/maturity stages research. Most of this research has dealt with the first generation of e-Government 1.0, focusing on a part of it that concerns informational and transactional electronic services provision. Layne and Lee [39] developed a model of e-government growth, which focuses on these services, and consists of four stages: i) the “catalogue” stage, in which static information is provided by government agencies to citizens and firms through the web; ii) the “transaction” stage, in which citizens and firms are offered the capability to conduct their transactions with the government (e.g. applications, declarations, etc.) through the web; iii) the “vertical integration” stage, which involves integration/interconnection of IS of government agencies of different levels (e.g. local, regional, national level) belonging to the same thematic domain (so that transactions conducted by citizens and firms at one of these levels are automatically propagated to and update all the other levels); iv) the “horizontal integration” stage, which involves integration/interconnection of IS of government agencies that belong to different thematic domains (so that transactions conducted by

citizens and firms with one government agency can update databases of government agencies from other thematic domains, and also use such databases in the processing of the above transactions), enabling the establishment of electronic one stop shops (regarded as the highest level of electronic transaction services). These four stages describe an interesting advancement that has taken place within the e-Government 1.0 generation with respect to the capabilities offered to the citizens and firms, and constitute four different distinct sub-generations of it. Subsequently, based on the above model many extensions/elaborations of it have been developed, which identify growth/maturity stages with respect to informational and transactional electronic services provision by government; comprehensive reviews/syntheses of them are provided in [40] [41][42][43]. According to the most recent of them [43] these models share the following main growth/maturity stages: a) publication of information on websites; b) bi-directional communication with citizens via electronic channels; c) offering transaction e-services online; d) delivery of integrated e-government services, which involve multiple government agencies from the same or even from different thematic domains, in an 'electronic one-stop shop' mode; e) some models include also an additional stage that concerns the above second generation of e-Government 2.0: e-democracy/e-participation related e-services. Furthermore, the same publication [43] distinguishes two additional stages of more advanced e-government transactional services, which go beyond the abovementioned electronic one-stop shop: the 'limited no-stop shop' and the 'no-stop shop' stages (in which the citizen has to perform only limited actions, or does not have to perform any action at all, respectively, in order to activate/receive government services). The maturity stages (a) to (d) (but not stage (e), as it concerns the second generation of e-Government 2.0, and not the first generation of Government 1.0), followed by the abovementioned two additional maturity stages identified in [43], constitute six distinct sub-generations of the first e-Government 1.0 generation, which are highly differentiated with respect to the capabilities offered to citizens and firms, and also the infrastructures and capacities that have to be developed by government agencies. However, it should be noted that there is a lack of similar maturity stages research concerning the other more 'basic' part of this e-Government 1.0 generation concerning the use of ICT for improving the efficiency of their internal operations and processes through internal intra-organizational IS of government agencies, though this is of critical importance for modern government and consume most of its ICT budget.

Much less similar research has been conducted for the second generation of e-Government 2.0, for identifying growth/maturity stages within this generation, and therefore corresponding sub-generations of it. In [17] has been developed an maturity model concerning the use of social media by government agencies for promoting public engagement and open government, which consists of five stages: i) the "initial conditions stage", in which limited open government capabilities exist and social media is seldom used; ii) the "data transparency" stage, in which social media are used for increasing transparency of government processes and performance by publishing relevant data online and sharing it with the public; iii) the "open participation" stage, in which social media are used for promoting open participation of the public in government work and decision, aiming to enhance policy decisions and government services by utilizing the input of the public; iv) the "open collaboration" stage, in which social media are used

in order to foster open collaboration among government agencies, the public, and the private sector, for completing collaboratively complex tasks or projects that aim to co-create specific outputs; v) the “ubiquitous engagement” stage, in which the main objective is to expand the scope and depth of social media use by citizens for all the above purposes, by making this easier and more universally accessible through mobile and ubiquitous computing devices and applications (so that the public can access government data and also participate and collaborate with government agencies using a wide variety of devices, such as smart phones, tablets, laptops, desktops, etc.). The first four of these maturity stages constitute distinct sub-generations of the second e-Government 2.0 generation with respect to purpose/objective of social media use.

Recently, a more focused maturity model has been developed concerning the use of social media by government agencies for ‘citizen-sourcing’, in order to collect useful public policy-related information, knowledge, proposals/ideas and opinions from citizens [44]; it can be viewed as an elaboration mainly of stages (iii) and (v) of the previously described model of [17]. It consists of five maturity stages of social media use for citizen-sourcing from a more technical perspective: a) set-up and manual operation of social media accounts; b) centrally managed automated operation of multiple social media accounts; c) centrally managed and automated monitoring of external social media accounts; d) centrally managed and automated monitoring of external social media accounts with quality filtering; e) use of internal social media for the internal dissemination of the information, knowledge, proposals/ideas and opinions from citizens collected through the mechanisms defined in the previous stages, as well as for internal consultation on them; it should be noted that stages (b) to (e) include automated processing of content created in them by citizens for extracting the main issues as well as sentiment. We remark that while the stages of the previous maturity model described in [17] concern the purpose/objective of using social media by government agencies, the stages of the model maturity described in [44] have a more technical perspective, and concern mainly the kind of social media accounts to be used for citizen-sourcing, as well as the way of managing them and processing the content created in them by citizens. This indicates that for one e-Government generation we can have several divisions of it into sub-generations from various perspectives, such as the purpose/objective of ICT use perspective, the technical perspective, etc.

The above sub-generations we have identified for the first two generations of eGovernment 1.0 and 2.0 deepen our understanding about them, and indicate that they are not homogeneous and static; on the contrary, they are complex, heterogeneous and undergo important evolutions and advancements. Each of these sub-generations might require different organizational capacities and infrastructures from its previous ones, and have different risks, challenges and critical success factors.

7 Conclusion and Further Research

In this study, we analyse the three different generations of e-Government. In order for this to be achieved it was necessary to first develop an appropriate analysis framework: to properly identify the main analysis perspectives, i.e. their main characteristics of

these generations to be examined. For these generation definitions were developed as a result of our research, and the main characteristics of them were identified, as well as their important differences in goals, orientations and means. It has been concluded that these three e-Government generations differ substantially in the targeted government function to be supported and enhanced using ICT: internal operations and transactions with citizens/firms for e-Government 1.0, communication and consultation with the society for e-Government 2.0, and decision/policy-making for e-Government 3.0. Furthermore, they differ in the specific ICT they use for supporting/enhancing their targeted government function, with each generation employing the most appropriate ICT for the function it targets: ICT infrastructures and interoperability, as well as web 1.0 for e-Government 1.0, web 2.0 and social media for e-Government 2.0, big data, IoT, analytics, machine learning and AI for e-Government 3.0.

Further research is required on one hand concerning the first two e-Government generations, in order to deepen our understanding of them, by introducing more analysis perspectives, such as the transformations they have driven, and their interplay with economic and social evolutions; also, it is necessary to analyse each of the identified sub-generations of them separately using the analysis framework developed in section 3. On the other hand, concerning the emerging e-Government 3.0 generation much more research is required, in order to address the fundamental questions it poses: Which are the main new disruptive technologies that will influence its development and shape it? How we can use these new disruptive ICTs in the public sector, on one hand for policy and decision making, and on the other hand for other functions of government agencies? – What major transformations they can drive in government agencies' policy and decision making, and also operations and work practices, transaction and consultation with citizens and firms, and in general in governance models? – Are there evolutions and advancements that create sub-generations within the e-Government 3.0 generation.

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