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Christophe Gaie
Mayuri Mehta *Editors*

Transforming Public Services— Combining Data and Algorithms to Fulfil Citizen's Expectations

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Editors

Transforming Public Services—Combining Data and Algorithms to Fulfil Citizen's Expectations

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Preface

In recent decades, public organizations have earnestly embraced digitalization to foster e-Government, transforming traditional administrative procedures into accessible online forms. Consequently, most administrative processes are now explained on public websites and can be accessed online. This modernization is applied to existing procedures by converting paper to electronic form. Today, electronic procedures are available for declaring annual income, paying taxes or traffic fines, registering at school, high school or university, obtaining social subsidies, retrieving unemployment benefits, and so on.

The transition to e-Government has been accelerated with the development of Information and Communications Technologies, yielding manifold advantages. Firstly, digital procedures enhance public service efficiency and empower citizens to independently navigate processes with 24/7 accessibility. Secondly, modernizing public services improves citizen satisfaction, as they can complete procedures independently with 24-hour/7-day availability, eliminating the need to visit distant administrative offices. Thirdly, citizens gain more information about their rights. Forth, public services offer higher transparency through extensive online documentation. Finally, public policies become more effective, impacting a large part of the population at a lower cost.

However, e-Government is still not satisfactorily implemented, and some limitations persist. The classic approach of replacing the former paper-based procedure with a simple electronic form is a significant limitation. While electronic forms simplify the user experience and reduce civil servants' tasks, they do not modernize the process. For instance, tax and customs declarations still require companies to hire employees to fulfil their obligations or develop IT software. Thus, a new automated process is essential, that independently computes and collects tax fees. Additionally, modernizing procedures often coincide with reducing public service establishments.

Presently, the services provided to citizens are perceived as distant and less personalized. This poses new challenges in guiding and assisting people who suffer from digital illiteracy, affecting more than 30% of the population of developed countries and hindering the adoption of digital public services. Consequently, it is crucial to consider citizens' education and ensure personalized, exceptional procedures for

disadvantaged populations. Furthermore, e-Government does not address the “non-take-up problem”, where citizens may not fulfil administrative procedures to obtain a subsidy if the effort does not seem worthwhile, especially for low and non-recurring amounts such as specific checks for mobility or energy consumption.

To address the abovementioned limitations, the authors propose accelerating the transformation of public services and transitioning from Electronic Government to Automatic Government (“a-Government”). This new paradigm offers higher benefits, having the government service itself performs administrative procedures from the citizen’s perspective. Simultaneously, it also alleviates the burden and ensures that every eligible citizen benefits from subsidies. Moreover, the automatic approach enhances the efficiency of public services, requiring better data exchange between public and private services, reducing fraud, and providing better support for low-income people.

This book delves into the a-Government approach, outlining strategies, secure architectures, and practical implementations through concrete use cases in education, agriculture, and human resources. It provides detailed methods and approaches to facilitate their implementation in other government organizations and inspires civil servants to develop new digital services for the benefit of citizens.

Paris, France
Surat, India
January 2024

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Chapter 1

Digital Transformation of Public Services: Introduction, Current Trends and Future Directions



Christophe Gaie and Mayuri Mehta

Abstract The digital transformation of public services is a key concern for government administrations as it optimizes services delivered to citizens, enhances the job of civil servants and increases the efficiency of government services. This chapter proposes an overview of the opportunities and challenges to consider for the implementation of e-Government. First, the concepts towards e-Government are defined to set common guidelines to the current book. Then, the chapter describes the challenges to implement e-Government that requires implementing an adequate ICT infrastructure, ensure security and privacy, acculturate the senior management and citizens to technology, and communicate on the availability of digitalized services. Afterwards, the authors describe the challenges of implementing cloud computing for government services notably in terms of security, privacy, technology readiness, and reliability. Finally, the authors detail new innovations that will radically transform the domain such as collaboration e-Government, Green IT, digital twin usage, or gamification. Throughout this chapter, the authors underline the importance of adopting a user-centric approach to fulfill the highest priorities of e-Government stakeholders.

Keywords e-Government · Public transformation · Digital transformation

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1.1 Introduction

From many years, the interest towards digitalizing government services is continuously increasing. As a matter of fact, Information and Communication Technologies (ICTs) are constantly improving and offering new opportunities in terms of data exchange, reutilization, computation, combination, etc. In the meantime, there is also a growing demand towards obtaining new services to perform public procedures everywhere, anywhere and above all easily. Each person involved in this profound change wonders whether Digitalization transforms Public Services or the reverse. First, let's define what e-Government refers to.

According to the United Nations, electronic government refers to the “use of ICTs to more effectively and efficiently deliver government services to citizens and businesses” [1]. This means that e-Government plays a role in the transformation of public services by facilitating their usage and increasing citizen acceptance. While e-Government was initially a domain reserved to specialists, the scope is now very wide with many dimensions tackled.

The emergence and growth of e-Government is a long process. Indeed, it requires gathering public policy requirements, human IT skills, information and communication technologies, as well as financial means to modernize government services. If one of these requirements is missing, then e-Government cannot flourish. The following figure illustrates this approach (Fig. 1.1).

Implementing e-Government also relies on a progressive transformation [2–4] that can be modelled in five stages of increasing maturity, from the web appearance with low services and interactions, to the seamless web with rich services, modern technologies and multiple citizen interactions.

The first stages of e-Government improved the efficiency of public services in terms of productivity, swiftness and preciseness as paper-based procedures were digitalized [5, 6]. However, it did not totally transform the perception of public services by citizen that still find public services complex and time consuming [7]. This explains the importance of underlining the importance of transforming public



Fig. 1.1 The necessary ingredients to develop e-Government

services by a citizen centric approach such as the e-Tax approach in Japan [8] and measuring citizen satisfaction [9].

While digital transformation and e-Government are largely tackled in the literature, there are many confusions between related concepts such as e-Participation, eGovernance, etc. As a consequence, a first objective of this chapter is to define these concepts and facilitate their understanding. A complementary goal of this chapter is to detail the current trends of the domain, especially the relations with the major trends of Information and Communication Technologies such as artificial intelligence, cloud computing, or cybersecurity.

1.2 Evolution of the e-Government Concepts

In this section, the authors define multiple notions necessary to cover the domain of e-Government. First, we explain and illustrate how e-Government expanded to tackle new concerns and offer better perspectives (the figure is inspired from [10]) (Fig. 1.2).

There are numerous publications concerning e-Government that is the common concept do describe the usage of ICT to improve government procedures and replace classic paper-based public services. A description of the concepts of e-Government was proposed by Fang [11] and gives the definition of e-Government, the types of e-Government, the differences with e-governance, the interactions between government, business and the civil society, the Research Issues in Public Administration, etc.

A recent literature review was proposed by Liva et al. [12] and provides a landscape of recent research concerning e-Government. The paper outlines that there are many challenges to overcome above technology in order to transform government processes. As a matter of fact, it is required to take into account organizational,

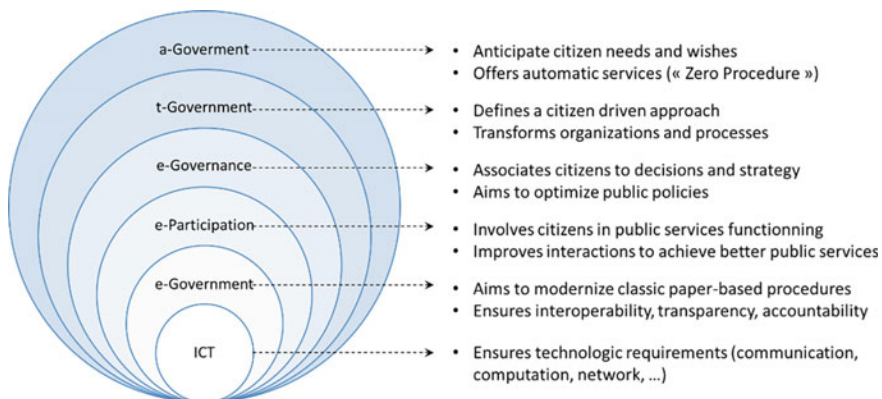


Fig. 1.2 The evolution of government approaches

juridical and social aspects to ensure that a new equilibrium is defined to achieve government procedures.

The following subsections hereafter describe in details each step concerning the evolution of government approaches to provide a strong theoretical background of the domain. In each subsection, the authors first describe the notions, then provide a bibliography of relevant papers in the literature, and finally provide a table that compares the content of cited papers.

1.2.1 About e-Government

Definition: e-Government refers to the initial approach of the domain that consists in modernizing public services or procedures thanks to the emergence of Information and Communication Technologies

Further information: e-Government is continuously enriched with new research directions (e-Participation, e-Governance, t-Government, etc.) Thus, e-Government may also refer to the comprehensive field of research

After several years of research and development of e-Government, Grönlund and Horan provided a relevant review concerning the domain that may be considered as a landmark [13]. The paper provides useful definitions and references to structure the different approaches adopted by researchers. A very important teaching relies in the understanding that e-Government is a cross-domain research field that notably combines legal aspects, public administration, computer science.

A key aspect in developing e-Government consists in guaranteeing to citizens that technology will preserve, and possibly improve, their legal rights to privacy, access to public services, reasonable government control, etc. These issues were tackled by Reitz [14], who underlines that technology raises new possibilities that involves both opportunities and challenges. As any other innovation, e-Government requires a transparent regulation that ensures a tradeoff between citizen rights, government efficiency as well as private sector growth. While the paper leans on the United States functioning in the 2000s, the conclusions may be generalized to many other countries and is still available in the 2020s.

After several years of expansion, it became crucial to reaffirm fundamental principles of e-Government. In [15], Alshehri and Drew described the different services offered: Government-to-Citizen (G2C), Government-to-Business (G2B), Government-to-Government (G2G), and Government-to-Employee (G2E). It also describes the benefits of e-Government as well as the multiple barriers to overcome:

Table 1.1 Summary of the previous work concerning e-Government

e-Government		
Id	Contribution	Limits
[13]	Provides useful definitions and references to structure e-Government	The number of references is limited to be considered as a review
[14]	Outlines the importance of a regulation concerning data used for e-Government	There is no concrete proposal to protect data
[15]	Details the principles of e-Government and identifies barriers	There is no proposal to overcome the difficulties encountered to implement e-Government
[16]	Describes the factors that enable the adoption of e-Government	The research does not tackle how to benefit from the identified enablers
[17]	Outlines that e-Government is facilitated by precise factors	A model is detailed but not concretely applied

infrastructure, privacy, security, regulation, training, partnership, digital divide, culture, management support. This paper plays a major role to understand the foundations of e-Government.

The experience towards e-Government also offers the opportunity to analyze and identify the factors that facilitates its adoption by citizens. As a matter of fact, Gupta et al. underlined that the adoption of e-Government is facilitated by performance and effort expectancy, social influence, trust in government and technology as well as citizen satisfaction [16]. These findings were obtained thanks to the implementation of a model that relies on the unified theory of acceptance and use of technology (UTAUT).

A comprehensive approach of e-Government was proposed by Malodia et al. that describe the evolution of e-Government in five successive stages, provide the results of interviews from various stakeholders (government officials, intermediaries, citizens and ICT experts), outline that the success of e-Government is facilitated by citizen orientation, channel orientation and technology orientation and moderated by the digital divide, economic growth and political stability [17]. The authors propose a model that rely on the Gioia method [18] and detail the outcomes of e-Government but do not apply it concretely. This is a perspective of research of their work.

The summary of the proposed literature concerning e-Government is provided in Table 1.1.

1.2.2 About e-Participation

Definition: e-Participation is a branch of e-Government that aims to involve citizens in the design and delivery of government-related processes

Further information: developing e-Participation implies to share the construction and the usage of public services with citizens. Involving citizens is a powerful mean to accelerate the modernization of government services

In the literature, the first experimentations to facilitate the emergence of e-Participation consisted in proposing a platform that enable the collaboration between civil servants and citizens [19]. Anthopoulos et al. describe how to implement these platforms operationally and detail the possible connection to future e-Government systems. This approach is intended to enhance the participation of citizens to the design of public services and improve their adoption.

A useful comparison between e-Government and e-Participation was proposed by Peristeras et al. [20]. The paper outlines that they both combine Society and Governance with the clarification that e-Government is associated to the government system part of Governance while e-Participation is linked to the political system of Governance.

The maturity of e-Government and e-Participation was examined by Krishnan et al. using a multiple mediation model [21]. The proposed model defines e-Participation as a combination of e-Information Sharing, a-Consultation and e-Decision Making. The authors applied their model to a set of data from 187 countries and outlined that technological infrastructure, human resources and e-participation are closely correlated to e-Government maturity.

The interest towards e-Participation was detailed [10] and the authors identified five core capabilities that enable citizens to achieve create value through e-Participation: ICT access, social interaction opportunities, equality between citizens, freedom of expression, and capability to acquire knowledge. The research outlines the current limits of e-Participation and recommend strengthening the core set of capabilities identified to make a further step forward.

After several years of expansion, a useful review of e-Participation was proposed Steinbach et al. [22]. The authors proposed a detailed approach that structures the domain in three successive phases: the adoption of e-Participation, its implementation and its institutionalization that aims to maintain it on the long-term. They also classify research depending on the level of analysis from the thinnest dimension of individuals to the systemic viewpoint of the organization; most of the literature is dedicated to the adoption and implementation of e-Participation at the macroscopic level of administration and at the organizational level.

Another valuable state-of-the-art concerning e-Participation was made by LeBlanc in [23]. It outlines the creation of multiple platforms dedicated to this objective and the inefficiency of this strategy. As a matter of fact, there is a need to better take into account citizens' expectations as well as the reluctance of government services to share with citizens the initiative of policy making. The author also proposes some ideas to associate citizens to policy-making processes.

The summary of the proposed literature concerning e-Participation is provided in Table 1.2.

Table 1.2 Summary of the previous work concerning e-Participation

e-Participation		
Id	Contribution	Limits
[19]	Proposes an implementation of e-Participation based on e-Government Groupware	The acceptance of inter-service collaboration is relatively low. This reduces the capability to deploy widely the system proposed
[20]	Provides a comparison between e-Government and e-Participation	The paper does not provide operational material to develop e-Government or e-Participation
[21]	Describes a model to define the interactions between source factors, e-Participation and e-Government	The approach is mathematical and not directly operational in a government context
[10]	Identifies core capabilities to facilitate the development of e-Participation	The proposal is not directly applicable in another context
[22]	Provides a classification of papers concerning e-Participation	The state of the art does not fill the gap identified
[23]	Underlines the importance to better take into account citizens' expectations and provides some proposals to improve it	There is no proposal

1.2.3 About e-Governance

Definition: e-Governance extends the domain of e-Government to the governance of ICT, to the satisfaction of citizens and their association to the decision process

Further information: e-Governance is a two-way protocol while e-Government is a one-way approach based on the provision of public services

The definition of e-Governance and its main contribution were detailed in [24]. As a matter of fact, Heeks underlined the improvement of government processes (e-administration), the better connection of citizens (e-services), and the emergence of external interactions (e-society). The author details many case studies to outline the limits of e-Governance. He also identifies the initiative to follow in order to improve e-Governance. While these orientations are mentioned, they are not specified in details.

The evolution towards e-Governance was also conceptualized by Finger and Pécoud in [25]. As a matter of fact, they outline the positive effects of new ICTs

with 1—the mere substitution of procedures, 2—the mirroring approach to offer information to citizens, 3—the emergence of new services for citizens and 4—the better efficiency of public services delivery. The authors propose a model where e-Governance depends on four cumulative factors (evolution of ICT, geographical level, functions to fulfill, and involved actors). While this model offers a valuable modelization of e-Governance, the research does not offer concrete implementation.

Rossel and Finger proposed another conceptual approach where e-Governance is a tradeoff between technology and institutional transformation [26]. They analyzed e-Governance through the prism of six dimensions, three types of actions, three geographic levels, and three functions that are similar to the approach of [25]. While this model is relevant to determine the factors involved in e-Governance, the research does not apply them to a concrete case study.

The difference between e-Government and e-Governance was also described by Hassan who underlined the fact that governance refers to a structure where institutions, organizations and citizens define a way to interact without being directed by the government [27]. The author also points out that e-Governance offers better services, information and transparency to citizens. This contributes significantly to democracy. While e-Government is illustrated by the case study of Bangladesh, there is no example for e-Governance.

The history of the evolution from e-Government to e-Governance was also explained by Dawes who underlines four major issues in [28]: 1—executive priorities¹; 2—legislative concerns²; 3—technology leadership³ and 4—Government-wide concerns.⁴ By tackling these issues, e-Governance brings substantial improvements such as the emergence of a policy framework, the development of better public services, the better efficiency of services by considering users' requirements, and finally, the improvement of citizen engagement. While the research is very useful to understand the evolution of the domain, it does not provide new proposals to develop e-Governance.

Finally, a very innovative approach that consists in proposing a platform that enable to implement concretely e-governance was proposed by Lee-Geiller and Lee in [29]. As a matter of fact, the authors propose the Democratic E-governance Website Evaluation Model (DEWEM) that relies on measure indicators such as Ease of Use, Capability of Interaction, Portal convenience, Privacy policy, Trust in portal, etc. Interestingly, an implementation of the DEWEM architecture is proposed and details the different steps to fulfill. Thus, the DEWEM was implemented with cumulative steps (preliminary studies, preparation of data, credibility check and final improvement. While the model is fully valuable, it was not tested in operational situations.

The summary of the proposed literature concerning e-Governance is provided in Table 1.3.

¹ Examples: education, security, economy.

² Examples: identity, privacy protection, data regulation.

³ Examples: Green IT, IT security, Health IT.

⁴ Examples: digital divide, privacy, governance.

Table 1.3 Summary of the previous work concerning e-Governance

e-Governance		
Id	Contribution	Limits
[24]	Details many case studies to outline the limits of e-Governance and proposes improvements	Does not detail improvements operationally
[25]	Outlines the positive effects of new ICTs for e-Governance and proposes a model	Does not implement concretely the proposal
[26]	Analyses e-Governance through different dimensions and identify the contributing factors	Does not apply the factors to concrete e-Governance use cases
[27]	Underlines the interactions between institutions, organizations and citizens in e-Governance	Does not provide examples concerning e-Governance
[28]	Identifies four major issues explaining the evolution towards e-Governance and identifies the different improvements	Does not provide new ideas to improve e-Governance
[29]	Proposes a model to evaluate e-Governance (DEWEM) and explain how to implement it	Does not apply the model to concrete case studies

1.2.4 About t-Government

Definition: t-Government refers to the shift from a digitalization of government services as performed by e-Government, to an in-depth transformation of the processes to fulfill citizen requirements and offer them the opportunity to be an actor of public policy making

Further information: t-Government goes further than e-Governance in the association of citizens as it offers them the opportunity to modify public procedures and propose new simplified approaches

The emergence of t-Government is a recent notion that refines the classic approach of e-Government. Irani et al. underline three directions carried out by t-Government: 1—focus on citizens needs and requirements to deliver public services; 2—develop a common culture of service⁵ to optimize the final value offered to citizens; and 3—improve the management of resources and skills to develop professionalism of public service delivery [30]. The paper offers crucial definitions, model and directions to initiate a dynamic towards the emergence of t-Government. However, there is a need to apply it to concrete case studies to verify the effectiveness of proposals.

⁵ This could be expressed as “Satisfy a client rather than deliver a service”.

Switching from e-Government to t-Government is not an easy process as it requires to better take into account the needs and expectations of citizens. Tony Blair, the former Prime Minister of the United Kingdom, gave an impulse to promote t-Government as indicated by King in [31]. The research also highlights the importance of developing a significant citizen-focused technology such as the customer relationship management (CRM) and proposes a four-stage maturity model. Interestingly, the author underlines a difficulty between stages three and four, as there is a barrier that is related to the traditional, bureaucratic government organizations. Unfortunately, the author does not indicate how to overcome this difficulty.

Above the idea of transforming government services through a user-centric perspective, t-Government also aims to improve transparency, accountability, flexibility and cost efficiency of public services. To fulfill these objectives, Janssen and Shu propose in [32] a framework based on three major axes: 1—defining the types of transformations to perform, 2—addressing the levels of abstraction involved and 3—choosing powerful supporting instruments. Although the framework is very helpful to implement t-Government, it is not immediately applicable as there is a need to define a methodology and to experiment it on a concrete use case.

After two decades of research concerning t-Government, Omar proposed a large review of the domain and highlighted the challenges, complexities and differences of approach in [33]. The authors analyzed the word frequency of 496 research papers in the domain and pointed the 50 most frequent words (the first one is “government”, then “public”, “information” ...) and built a word tree of research topics. While this paper provides a very important review of the domain, it does not propose a clear classification that can be reused in further research.

The new concept of digital government ambidexterity (DGA) was imagined by Björnses and Ivarsson in [34] and refers to capacity to take simultaneously advantage of incremental and radical digital innovations to bring value to public service. This concept was modelled and optimized by Ndlovu et al. in [35] to verify the hypothesis that “Digital Government Ambidexterity influences Public Value Creation” using a sample of 690 citizens using digital government platforms. The research proved that DGA has a significant influence on information usability, completeness, readability, trustworthiness, and relevance. This means that DGA can play a major role in the development of t-Government to fulfill citizens expectations. While this research provides meaningful information, the methodology relies on the perfectible approach of self-completion questionnaires.

The summary of the proposed literature concerning t-Government is provided in Table 1.4.

Table 1.4 Summary of the previous work concerning t-Government

t-Government		
Id	Contribution	Limits
[30]	Defines t-Government and provides a model and directions to initiate a dynamic	Does not apply the proposals to concrete case studies to verify their effectiveness
[31]	Highlights the importance of developing a significant citizen-focused technology such as the customer relationship management (CRM) Proposes a four-stage maturity model	Does not propose a solution to the barrier that appear between stages three and four of the maturity model
[32]	Proposes a framework based on three axes	Does not implement t-Government on a concrete use case
[33]	Provides a very important review of the domain	Does not propose a clear classification that can be reused in further research
[35]	Offers meaningful information	The methodology relies on the perfectible approach of self-completion questionnaires

1.2.5 About a-Government

In this book we propose to introduce a new approach entitled “a-Government” (Automatic Government) that aims to provide automatically public services to citizens. The perspective pursued is to reduce the administrative burden supported by citizens as well as reduce the no recourse to public subsidies such as minimum revenue, tax credit, environmental aid, etc.

As a matter of fact, the modernization of government services enables to achieve many procedures by internet such as tax reporting, public institution enrolment, booking an appointment with a civil servant, obtaining a public subsidy, etc. This evolution clearly improves the interaction between citizens and government services by avoiding the former to go to the appropriate service and the latter to replicate data from a paper form into the appropriate database. However, citizens still have to achieve the procedure and some of them can also encounter electronic barriers due to digital illiteracy. This is the reason why a-Government will provide better user experience with, for example, reporting revenues automatically based on pay declaration of employers or granting subsidies based on the data already held by government services.

Another perspective towards a-Government is the capability to propose personalized services to citizens by taking advantage of Artificial Intelligence. Indeed, a valuable improvement would be to perform services from a simple event. For instance, a pregnancy declaration could imply the completion of a demand to obtain a place at the nursery; a birth could trigger the automatic creation of a social insurance record; reaching the age of the majority could result in a voter registration. The usage of AI could also enable suggestions such as proposing student accommodation to young people who register to the university, propose a medical appointment with a specialist when multiple medical acts are detected, etc.

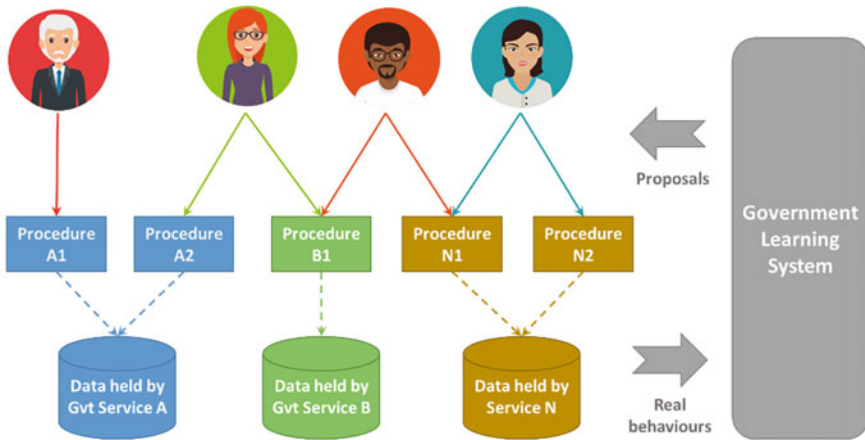


Fig. 1.3 A possible implementation of a-Government

An interesting approach could be to inspire from other citizens behaviors such as market places do. This refers to the principle of a similar track (i.e. “Other customers also bought these items”) that can be learnt by a Government Learning System (Fig. 1.3).

1.3 The Public Value of Transforming Public Services Through e-Government

In this section, we describe the public value of e-Government based on the existing literature. A key point consists in identifying the levers that encourage to modernize public services and favor e-Government. Karunasena et al. proposed a very useful framework that identifies four sources of public value creation from their literature review [36].

1. **Delivery of public services:** this perspective evaluates notably the quality of information delivered to citizens, the amount of data available, and the simplicity of public service usage. It aims to measure the satisfaction of citizens towards public services.
2. **Achievement of outcomes:** this dimension aims to measure the social outcomes obtained from the modernization of public services. The evaluation takes into account the impacts, the deliverables, and the consequences of e-Government for the society.

The authors of this chapter consider that other outcomes should also be considered. For instance, the impacts on the environment (i.e. greenIT) should be considered.

3. **Development of trust:** this perspective enables to examine whether e-Government offers an adequate protection of personal information (security and privacy), details the process of public decision making (transparency), inspires confidence in public services (trust), and contributes to enhance the involvement of citizens in governmental action.
4. **Effectiveness of public organization:** this dimension aims to ensure that e-Government improves the functioning of public services through cost reduction, better performance, and higher inter-service collaboration. For each significant evolution, a measure of the financial return of investment in public organizations is required to assert the effectiveness of the organization.

An interesting method to combine and compute the value of these levers was proposed by Mensah et al. [37]. In their research, the authors propose a public value of e-Government adoption model (PVEGAM) that combines the data using seven hypotheses whose validity was asserted using a questionnaire completed by Chinese. This survey contributed to evaluate the relation between levers and public value of government (mathematical correlation). The highest contribution comes from the efficiency and just behind it the quality of information.

Finally, a crucial approach concerning the public value of e-Government consists in evaluating the perception from different point of views. Indeed, as described by Castelnovo, the citizen is alternatively a decision-maker, a civil servant, a participant of a process, or a taxpayer [38]. As a consequence, the public value perceived by a given stakeholder depends on the role it endorses.

To initiate new research approaches, we propose here to model the problem as an optimization problem. The objective pursued is to maximize the return on invest (ROI) of an effort to increase public value (i.e. the sum of each factors described by Karunasena, Mensah, or any other researcher) while ensuring a minimum value for each stakeholder. Define the following variables.

- i a given improvement of the public process
- $d(i)$ the delivery gain obtained from improvement i
- $o(i)$ the outcome gain obtained from improvement i
- $t(i)$ the trust gain obtained from improvement i
- $e(i)$ the effectiveness gain obtained from improvement i
- $c(i)$ the cost of improvement i .

Thus, the ROI of improvement i may be expressed as:

$$ROI(i) = d(i) + o(i) + t(i) + e(i) - c(i)$$

Consequently, a first objective would be to identify the list of improvements $\{i\}$ that maximizes the ROI:

$$\operatorname{argmax}_{\{i\}} \sum_{\{i\}} [d(i) + o(i) + t(i) + e(i) - c(i)]$$

This objective may be easily refined by introducing the stakeholder perspective. To this end, we define:

- $[AD] = [ADd, ADo, ADt, ADe]$ the vector that defines the level of acceptance on each factor for a decision maker
- $[AP] = [APd, APo, APt, APe]$ the vector that defines the level of acceptance on each factor for a participant
- $[AT] = [ATd, ATo, ATt, ATe]$ the vector that defines the level of acceptance on each factor for a taxpayer
- $[AS] = [ASd, ASo, ASt, ASe]$ the vector that defines the level of acceptance on each factor for a civil servant

As a consequence, the problem to solve is:

$$\operatorname{argmax}_{\{i\}} \sum_{\{i\}} [d(i) + o(i) + t(i) + e(i) - c(i)]$$

With the following constraints:

- $d + \sum_{\{i\}} d(i) \geq \max(ADd, APd, ATd, ASd)$
- $o + \sum_{\{i\}} d(i) \geq \max(ADo, APo, ATo, ASo)$
- $t + \sum_{\{i\}} d(i) \geq \max(ADt, APt, ATt, ASt)$
- $e + \sum_{\{i\}} d(i) \geq \max(ADe, APe, ATe, ASe)$

Finding the optimal combination of improvements $\{i\}$ to maximize the ROI is a classic optimization process. The method to solve this problem relies on convex optimization and is detailed in [39], multiple examples are provided in [40] and [41].

A key point of this approach is to define suitable constraint vectors to ensure that the problem may be solved. To verify the convergence of the algorithm, setting the constraints at a low level is recommended.

1.4 e-Government Current Challenges

A key concern of e-Government is the capability of government services to move from theory to practice. As a matter of fact, the context of public services is currently very constrained in many dimensions. The successive financial crises reduced the financial means and human resources of ICT government services while requiring higher results in terms of efficiency, data protection, intelligibility, interactivity, and service coverage.

These challenges applies to every country whether it is supposed to be rich, in development or poor since the barriers to implement e-Government apply in any situation. To illustrate the current challenges for e-Government we propose the following figure inspired by Meiyanti et al. in [42] (Fig. 1.4).

While the next section is dedicated to highlight the current trends to enhance ICT government services, it is crucial to underline the importance of taking into

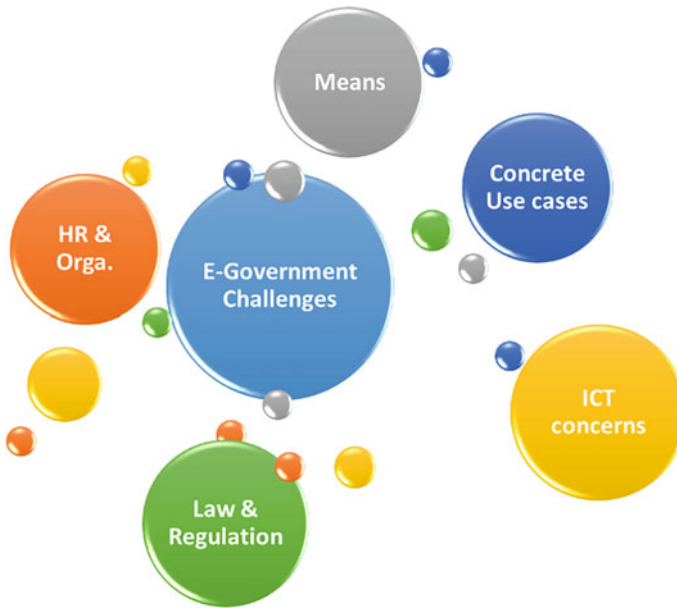


Fig. 1.4 Current challenges to develop e-Government

account concrete use cases. As a matter of fact, IT engineers and researchers often tend to solve theoretical problems that still have to be adjusted to real-life situations. This explains why we pay particular attention to detail the implementation of e-Government in concrete use cases such as education [43, 44], healthcare organization [45, 46], agriculture efficiency [47], or fraud detection [48].

A simpler model that identifies barriers and challenges to implement e-Government was proposed by Arief et al. in [49] based on a limited sample of 20 articles. The model relies on three major domains: technology, organization and human resources. The research outlines 34 concerns where the most recurring barriers are the lack of IT infrastructure, the insufficient IT security, the excessive financial constraints, and the policy. While the analysis is promising, it should be further detailed by including other valuable papers, providing a deeper analysis of barriers and proposing levers to overcome them.

A valuable analysis of current trends in e-Government was proposed by Heidlund and Sunberg based on the keywords of 720 articles that were analysed using VOSviewer [50]. The research splits data into seven clusters: 1—general information concerning e-Government, 2—general information concerning e-Governance, 3—service quality, 4—calculus, 5—digital divide, 6—risk management, and 7—technology acceptance. The authors also analyze the content of the highest cited papers and conclude that a majority of papers focus on the quality of their service without analyzing government service as a whole. Thus, the author propose