



The digital governance puzzle: Towards integrative theory of humans, machines, and organizations in public management

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ABSTRACT

In recent decades, the world has been undergoing extensive digital transformations, often described as the fourth transformative industrial revolution in human history. This revolution, replete with technological innovations and information society platforms, has dramatically altered many aspects of modern life. Governments and public administrations also play a major role in this revolution. They confront the challenges of regulations, various biases and barriers related to digital transformation, interactions with citizens in a highly technological environment, and the changing civic and political culture. This paper seeks to address major missing links in the digital governance puzzle. We suggest conceptual, epistemological, and empirical additions to current literature in this territory highlighting the need to integrate knowledge from various perspectives. Using a threefold interaction framework of human-machine-organization we develop a model to analyze the complex mechanism in which digitization processes in the public sector influence the behavior, performance, and values of public organizations. The model highlights the potential mediating role of perceptions of the Digital Governance Footprint (DGF) and people Mental and Emotional Models (MEMOs). Finally, we explain how multi/mixed-method analysis can support our model, using process-tracing strategy, comparative case studies, surveys, survey-experiments, and lab experiments.

1. Introduction

In recent decades, the world has been experiencing extensive digital transformations. Often described as the fourth transformative industrial revolution in human history [1], this process is intensifying and accelerating every year. It abounds with sophisticated technological innovations and information society platforms, which have dramatically altered many aspects of modern life, triggering philosophical discourse and empirical research regarding its long-term implications and future directions (e.g., Ref. [2]; Gil-Garcia, Dawns, & Pardo, 2018). Governments and public administrations also play a major role in this revolution, financing many of these initiatives, regulating their emergence and operation, and using their outcomes in a variety of domains [3,4]. Moreover, the digital revolution is generating new power bases in society with which governments must contend (e.g., virtual communities, cryptocurrencies, international networks of knowledge). While this revolution is redefining democratic rules and values, it is also prompting more government regulations and interventions to safeguard public interests and the public good (e.g., Ref. [5–7]). In that vein, government-

citizen relationships take new directions, advancing towards smart governance [8] and intensifying the adoption of innovative digital tools and technologies aimed at improving public sector performance [9,10].

These and other challenges are at the core of our paper. We maintain that digitization in public management and governance has advanced considerably over the years. Several waves of development profoundly transformed the field and created a highly sophisticated and technological-based managerial culture. This transformation infuses new ideas about algorithm and machine-based reforms, progress based on interdisciplinary knowledge and technological advancement, and a strong orientation towards IT/ICT and big data sources. We experience faster and more extensive transfer of data among stakeholders, especially between citizens as end-users and bureaucracies, but also within governance agencies. More recently, ideas like artificial intelligence, machine learning, and the metaverse have also become more prevalent in public administration, public management, and governance studies (e.g., Ref. [11,12]) and has the potential to promote additional waves of changes. Undoubtedly, digitization has become the greatest power multiplier of the public interest over a relatively short period of only a few

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decades. It plays a major role in redefining theoretical boundaries of the discipline and in advancing practical ideas for building stronger nations and intelligent governance ([13], 204–5; 2024). Above all, it has planted the seeds of a profound cultural and value change in public organizations and government responsibilities.

However, there are indications that the extent and depth of these digital transformations in public sectors lag far behind the technological developments in business industries [12,14,15], and that the gap between machines, humans and organizations even widens in various ways. Many citizens and public institutions face great difficulties in handling these new digital tools (e.g. Ref. [10]) and, generally, the exact effects of the digital revolution on individuals such as public servants or citizens, on the performance of public organizations as bureaucratic bodies, and on the relations between governments and citizens remain unclear [9]. Integrating digital transformation into governance and public management reshapes and recharacterizes the social relations between all parties involved in the production and consumption of public goods and services. These new forms are also leading to new and serious problems across the human, organizational, and overall policy levels (e.g., increased inequality, lower social mobility, corruption, differentiation in service delivery and outreach, changing nature of public jobs; e.g., Ref. [16]). Current studies on public administration and management either tend to suggest general, often philosophical, analyses of these processes, or focus on very specific aspects of the dilemmas, thereby leaving considerable room for more integrative, empirical, and multi/mixed-level models to grow and flourish (e.g., Ref. [4]).

Our paper takes a more holistic view, proposing theoretical and empirical directions for further advancing this field and narrowing these gaps in both epistemological and empirical thinking. To this end, we suggest dealing with the complexity of the digital revolution in governance and public management by laying integrative theoretical grounds for analyzing and understanding the core mechanisms through which new governance addresses the challenges of the digital revolution. This theoretical framework includes opportunities, threats, barriers, biases, and innovations at the organizational, individual mental-emotional, social, and political levels. To meet these goals a consolidative model is suggested, with an emphasis on human interfaces between machines and public organizations. We expect that it may help in better analyzing these problems and set a comprehensive research agenda for the field. This agenda includes, but is not limited to, (1) development of new concepts, (2) introducing major questions and models, (3) suggesting core variables and their potential interrelations, and finally (4) proposing directions to trace the answers using a variety of methodologies. Based on past progress and writing, we aim at opening new avenues of both research and practice that can inspire public discourse on a more comprehensive understating of digital public management and governance for the years to come.

2. From bits and bots to metaverse

2.1. A brief evolution of digitization in public management and governance

Digitization in public management and governance has gone a long way since the first use of digital bits during the technological revolution of the information society in the late 1970. Today, almost four decades later, we witness straight talks about bots, robots, and metaverse government ([12]; Wyld, 2008) which totally transform the way we define modern governance and public management. The roots of change may be tracked back to the emergence of classic public management. In its first evolutionary wave, public management was heavily inspired by widespread global market orientations, a strong neo-liberal ideology, and greater ambition to increase performance and promote a business-like public sector ([17]; Vigoda, 2002; Young et al., 2020). These intellectual avenues paved the way to greater openness, growing creativity,

adaptation of technological innovations, long-range planning, extensive entrepreneurship spirit, and far-reaching modernization that allowed the rise of digitization as a second wave of public management revolution. However, many digital transformations of early days, especially during the late 1970s and 1980s, were premature and perceived suspiciously as unsustainable, unrealistic, or simply too hard to adopt [18].

Digitization was further at the heart of the second wave of changes in public management and governance of the 1990s and early 2000s [18–20] and opened the gate to new ideas on public reforms and progress. Greater sophistication of computer-based technology together with fast adjusting human skills resulted with ideological change in public organizations allowing entrance of machines and new-age algorithms. Larger number of open information platforms (e.g., e-mails, social media, large files exchange, bigger capacity of memories, sophistication of hardware and software platforms) allowed faster and more extensive transfer of data, knowledge, and experiences at all levels of government. Consequently, since the early 2000s we have witnessed rapid transition from human-based to machine-based public management, and even more so to a human-machine interaction (HMI) style of government. This transition is accompanied by a variety of dilemmas (e.g., Roy, 2017) such as strategic development (when and in what form to use), practice (how to use), and ethics (what is the moral impact of this use?). Overall, it seemed that the fields of public administration and management struggled with great challenges and barriers, most of which have not been analyzed systematically even until today ([21]; Torfing et al., 2021).

The rise of machines such as bots, robots, and algorithms in the first two decades of the 2000s signaled a third wave of digital transition that lasts even today. Machines based on high-technology use big-data and multisource information systems gradually penetrate the public sector and have the potential to dramatically change government activity in many ways [18]. Machines are involved in almost every segment of public activity. For example, they are used to help policy makers in deciding better (e.g., Ref. [14]); they help bureaucrats (and street-level bureaucrats) in providing better services (e.g., Ref. [6]); they assist the control and auditing circles in better supervising governments outputs (e.g., Hunt et al., 2021); and they take the lead in interacting with citizens and other stakeholders (e.g., Ref. [22]). One of the fields that is leading these processes is national security and defense, where digital systems are intensively replacing humans in a variety of missions related with homeland security and military actions in land, marine, and air combat zones (e.g., Horowitz, 2020; [23]). Digitization is also increasingly used in diplomacy and foreign affair tasks (e.g., Adler-Nissen & Drieschova, 2019), healthcare, education, welfare services, and other public services. Overall, integrating machines like bots, robots, and algorithms in all fields of governance responsibility is aimed at improving the quality of decisions and policies, enhancing responsiveness and services to citizens, and better using governments budgets and resources [5]. But maximizing its full potential still rests in advanced integration among major players: People, machines, and bureaucracies. The next section extends on the nature and challenge of such integration.

3. The digital trio in governance

3.1. Theoretical foundations for the humans-machines-organizations link

At the core of our theoretical framework is the idea that digitization in governance and public management involves a threefold interaction between humans, machines, and organizations. This idea is illustrated in Fig. 1. It challenges the conventional thinking of various disciplines and builds on two separate but complimentary streams of research. The first is the extensive field of Human-Machine Interactions (HMI), which has expanded as the digital revolution has progressed in modern societies. Many studies suggest philosophical, moral, technological, and

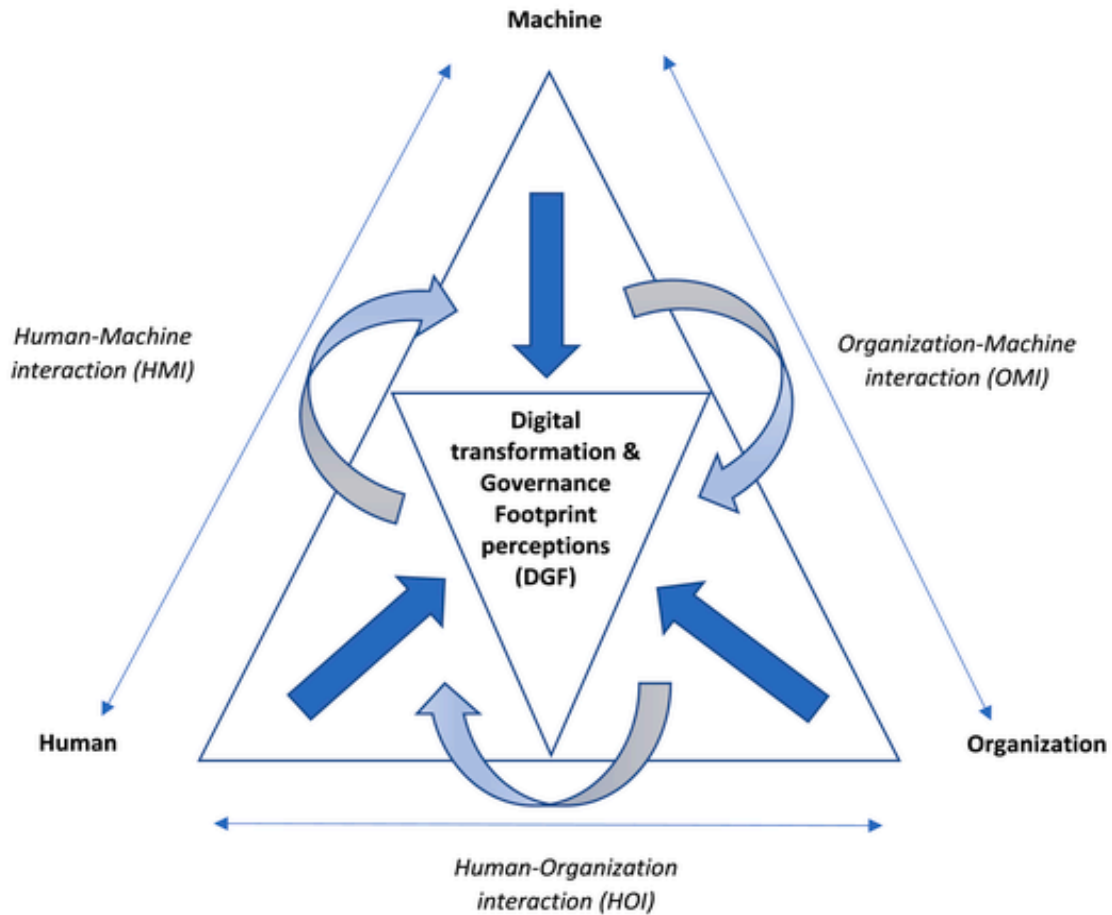


Fig. 1. The digital public management and governance trio: Human-machine-organization.

psychological aspects of how individuals interact with machines and the implications of those interactions for society (e.g., Ref. [24–27]). Much of the literature on HMI is technological in nature and rooted in (social) engineering. Consequently, the idea of HMI is largely overlooked in public administration. Thus, it is essential to examine how people in and around governance interact with various types of technology (e.g., computerized systems, bots, robots, technological service interfaces, algorithms, etc.), how they respond to such interactions, and how such interactions affect individuals (on the mental and emotional levels) and bureaucracies (on the outcome, performance, and value levels). We follow Reid and Gibert [28], who recommended extending the impact and examination of this HMI knowledge across diverse subjects to benefit all people. The second field to which we seek to contribute is strategic management, organizational and policy studies, which tend to focus on organization-machine interactions (e.g., Ref. [29,30]), and much less on human-machine interactions. More is known today about how humans and machines interact in the digitized world, but much less is evident about the interplay between humans and machines on one hand, and on the other hand organizations and bureaucracies in public spheres. The existing literature emphasizes technological and engineering aspects of these interactions in the context of the triptych technology, organizations, and people (TOP model) [25,31,32]. We suggest that when these lines of thinking are integrated with knowledge on human-organization interactions (e.g., in organizational behavior or cognitive and applied psychology), they may foster a more comprehensive framework for the role of the digital revolution in public spheres. A further outcome may be the emergence of a hybrid and interdiscipli-

nary sub-field, related to the human-machine-organization trio, and an inspiring new cluster of theories and ideas.

We therefore maintain that a closer look into the three circles of interactions allows better understanding of processes, reactions and implications of the digital transformation era and explore the digital government footprint on our lives. Thus, we strive to contribute to various theoretical, empirical, and practical fields such as (but not limited to) organization and management, organizational and applied psychology, social psychology, business, technology and digitization, public administration, public policy, governance, and political science. This may further result with the emergence of a hybrid and interdisciplinary sub-field, relating with the human-machine-organizational trio, and aspiring new cluster of theories and ideas.

Fig. 2 presents our core conceptual framework, which includes several building blocks that are closely interrelated and later lead to a set of propositions. As a starting point, we take the existing structural conditions that characterize the public sector and emphasize its uniqueness and centrality for modern nations over and above the private or the third sector (i.e., organizational structure, culture, and the sociopolitical environment of the public sector). We argue that the opportunities and challenges for change in governance and public management are rooted in developing suitable digital and information technologies that may help improve public sector management and effectiveness. When public administrators become more aware of these developments, they may become more likely to initiate and adopt new forms of digital transformation that coexist with and benefit the interests of individuals, organizations, and the public. This complex process involves

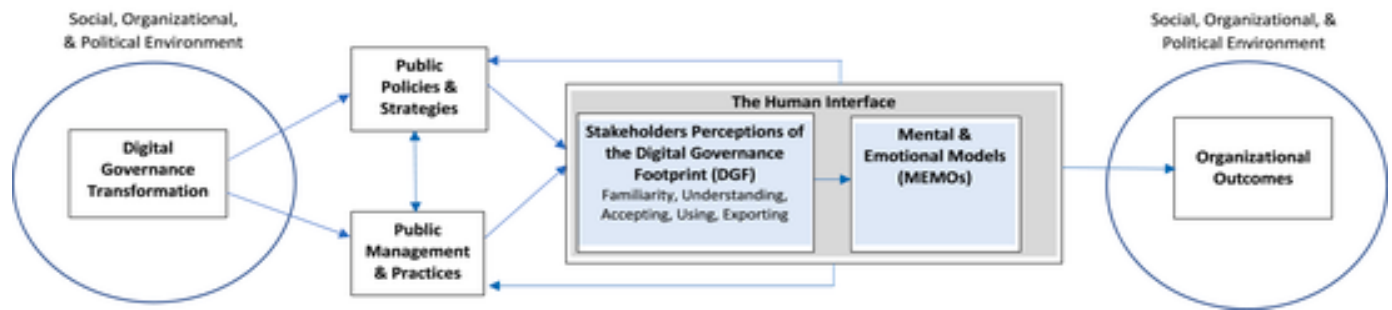


Fig. 2. An integrative model of human-machine-organization interaction in public spheres.

organizational elements and personal and psychological mental-emotional models (e.g., Ref. [33,34]). Both individuals and organizations in public spheres may be affected by the special sociopolitical and technological environment in which public administrators operate. To understand the relationships between the multiple levels and sheer volume of actors in digital-era government, a more detailed and consolidative model is needed that specifies the mutual impacts and rationalizes them in a way that can foster not only theoretical progress but also concrete empirical development.

Fig. 2 presents core pillars for such a model. It suggests that digital transformation may be regarded as an exogenous factor that is intensifying over the years with every new digitization wave. Its impact on our lives is dramatically increasing, not only with natural technological advancement, but also due to external events such as the outbreak of the COVID-19 pandemic [4,20,35] and other global crises, such as international conflicts, the global terror threat, and environmental hazards [36]. Greater digitization heavily affects public policies and strategies, and rapidly translates into managerial practices at the organizational and street-level bureaucracy. The COVID-19 global crisis exemplifies how digital platforms of human tracking and data mining can be used by governments, in this case, to deal with the pandemic. But at the same time, it also illustrates how the same technologies can create quite troubling problems related to privacy, human rights, citizens' trust, and other impacts on democratic values (e.g., Ref. [37,38]). It is therefore argued that in such circumstances, interactions between humans, machines, and organizations become more complex and therefore also deserve special attention. As humans are at the crossroad between technology/digitization and organizations/policies, they may become the missing link in knowledge and practice. The human interface is comprised of two major elements – individuals' perceptions of and their emotions towards digital governance [39]. These constructs, which are the results of digital governance transformations, are built on stakeholders' perceptions of the Digital Governance Footprint (DGF) and their Mental and Emotional Models (MEMOs). The next sections elaborate further on the meaning of these notions and how they are integrated within our proposed model.

4. Digital governance and the human touch

4.1. Conceptualization

Digital governance transformation is the process of creating, adjusting, and adapting various technologies in public agencies in order to improve internal management processes and external outcomes, such as services to citizens and relationships with other stakeholders [40]. It is a process of moving from traditional government to new, innovative, and digital-based forms of e-government and data-based policies by deploying new initiatives promoting a broader technological-business orientation in public agencies. Studies suggest that this process of digital governance transformation is related to a complex set of variables,

some not necessarily related to technology (e.g., the nature of the target population, the proxies used for technology assimilation; [41]). It is further argued that “the introduction of new technologies by governments is always mediated by organizational, institutional, legal, ethical and social factors” and that “digital technologies may transform virtually every process, system and structure of government, resulting into redefinition of responsibilities and work routines of public officials” ([42], 502). Digital governance transformations may be affected by a small set of social, organizational, and political factors that are relevant to a specific environment. These may include (but are not limited to) openness to change and innovation in a specific culture or organization, power distance, uncertainty avoidance, long-versus short-term orientations (e.g., Ref. [43]), governments' policies on the planned adaptation of new technologies, organizational climate, and knowledge-sharing norms and regulations. Clearly, virtual media and internet networks are significantly extending and accelerating digital transformations in government using mega-data sources for both constructive and less constructive goals. A handful of studies stress the centrality of machine-organization axis while marginalizing the human aspects of such interactions. Thus, the role of important human factors, such as perceptions about digital governance, mental models, and emotions of the individuals involved in such dynamics are understudied and deserve greater attention (e.g., Ref. [15,39]).

Stakeholders' perceptions of the Digital Governance Footprint (DGF) represent stakeholders' perceptions of the digitization of governance. It refers to stakeholders' attitudes towards a variety of technologies, systems, and tools involving digitization and used in or by the public sector. Individuals' perceptions of these include attitudes and behaviors related to the digital government landscape (e.g., Information Communications Technology, ICT; Christensen & Lægred, 2022), and its importance in the provision and consumption of public services and goods. We argue that perceptions of the DGF may be used as both a conceptual tool for intellectual thinking and as a useful empirical vehicle for advancing the field. In fact, the idea of the DGF draws substantially from the environmental studies idea of the ecological footprint (e.g., Ref. [44,45]) and its use in public policy arenas (e.g., Ref. [46,47]). These studies seek to measure the impact of humans on their environment by means of their use (and misuse) of environmental resources in daily life. For example, Gottlieb et al. [47] demonstrate how the ecological footprint can be related to the citizenship behavior of high school students and other studies suggest methodologies to measure it and evaluate its impact on other populations (e.g., rural and urban residences) and on organizational and governmental policies [46]. We believe that the idea of the DGF has much to offer to our understanding of the e-government era [20] as an independent perceptual and cognitive measure of humans' interaction with the digital government world. This approach is also documented in recent public management studies (e.g., Ref. [10]) and reflects a collective and subjective perspective on the meaning of digital governance for end users and on the impact of technology on humans and their environment.

As much as humans leave their footprint on the environment, governments may well also leave a technological footprint on humans and the environment. Thus, perceptions of the DGF may be best conceptualized as a five-tier model comprised of stakeholders' views on: (1) *familiarity* with digitization in government, (2) *understanding* digitization in government, (3) *accepting* government digitization as an essential tool for policy and management, (4) *implementing* knowledge about government digitization and using digital tools, and (5) *disseminating knowledge* about government digitization to others. We will argue that perceptions of the DGF may be assessed in regard to various digital infrastructures and tools. Broadly, they may be understood as placing humans at the digital transformation's center by focusing on their reaction to government digital transformations. In that sense, perceptions of the DGF differ from the digital transformations and offer an innovative understanding focusing on public stakeholders' subjective views on the use, spread, and centrality of technology in public spheres. All these aspects of DGF should be reflected in sound measurements, scales, and testable ways to assess them.

Mental and Emotional Models (MEMOs) are suggested as another construct for representing human interfaces, one that could play a mediating role between perceptions of the DGF and organizational outcomes. Mental and Emotional Models are widespread in behavioral sciences and are influential when considering human reactions to various life events. Since the emergence of the technological and digital revolution, they have played an even more important role, and the interest in such models for dealing with machines is on the rise (e.g., Ref. [25,48,49]). The MEMO approach is based on the idea that core stakeholders like policymakers and citizens become dominant players in a digital sphere and respond to perceptions of the DGF. The responses may vary across a large scale of attitudes and behaviors, which depend on personal mental models and on the emotions of public stakeholders (e.g., uncertainty, anxiety, anger, fear, alienation, frustration, kindness, fairness/equity, solidarity, satisfaction, trust, happiness, etc.). Studies combining cognitive psychological theories with knowledge in engineering and computer science use mental models and emotions to explain human-machine interactions. Such studies (e.g., Ref. [39,50,51]) lay the foundations for our argument, as they illustrate which emotions may be important (e.g., happiness, anger, sadness, and fear) as well as in what cases, fields, and services they are relevant (e.g., transportation, healthcare, welfare, and security). These studies, and others in public administration (e.g., Ref. [39]), empirically demonstrate the centrality of individuals' cognition and emotions and how they may be used to explain digital governance outcomes and performance. They imply that many attitudinal, dispositional, and behavioral reactions are subject to emotional interpretations, and explain how these may affect various public values (e.g., exit, voice, neglect, loyalty, engagement, ethical behaviors, participation in decision making [PDM], and public service motivation [PSM]). Hence, the mental and emotional landscape for dealing with digital governance should be carefully mapped and may propose new ways to explain organizational outcomes as reflected in government performance in the digital age (e.g., Ref. [14,52]).

Furthermore, the mental and emotional responses of individuals to the rise of machines and digitization may additionally depend on previous personal experiences, and on socioeconomic conditions such as education, income, gender, and age. Public management literature usually studies human-machine and organization-machine interactions in the e-government context, mainly looking at structural-organizational parameters and socioeconomic conditions (e.g., Ref. [53,54]), with less attention to e-government' cognitive-psychological or sociopsychological aspects. Consequently, studies in these fields rarely refer to mental models and emotions as important determinants of digital transformation processes. To fully understand humans-machine-organization interactions, we must focus on individuals' interpretations of the public

digital/technological sphere in terms of DGF perceptions and MEMOs. In the following sections we elaborate on the model and its building blocks. These will lead to several new directions for future research, using measurable variables, propositions relating them, and finally also potential methodologies and analytical paths.

5. Towards integration

5.1. Exploring human-machine-organization interactions

The theoretical framework developed in this paper is designed to address four major pieces of the digital government puzzle. First, what are the barriers and biases that may influence the mechanism of digital transformation in public organizations, and how do they relate with the outcomes and performance of these organizations? Second, what is the nature of interactions between machines, humans, and organizations and how they relate with public management practices and with government policies? Third, how do the complex mechanisms of human-machine-organization relations influence the public sector performance and values both in terms of outcomes and processes? And finally, how does the human interface become so prominent in such relations, by means of perceptions of the Digital Government Footprint (DGF) and MEMOs?

5.1.1. The interactive process: rationale and logic

What is the evolution process in digital transformation and what impact does it have on policies, practices, individuals, and organizations in the public sphere? Undoubtedly, such evolution faces barriers and biases that may influence its progress and affect the performance and effectiveness of people, agencies, and bureaucracies [9]. One way to deal with this issue is to analyze digital transformation as a type of reform that most, if not all, public agencies around the globe have had to face in recent decades. If analyzed as a type of reform, digital transformation in government may use ideas rooted in New Institutionalism theory. Studies suggest that most of these reforms share many similarities [55,56] and are thus subject to a generic analysis. Pollitt and Bouckaert [56] suggest a schematic model of public sector reforms that depicts the main forces and players in such processes. They point to (1) *socioeconomic forces*, including global and technological forces, (2) the *political system*, including citizens' expectations and new political ideas, (3) the *administrative system*, which involves both policy planning and policy implementation, and (4) *chance events*, representing unexpected events such as innovations or crises and emergencies. All these factors interact with each other and influence policymaking, and reforms. Yet, this structural model overlooks individuals' reactions and other personal and personality factors. We suggest that these may be important variables for explaining public sector reforms in general, and especially when dealing with digital transformation as a major borderless reform with global, cross-sectorial, and cross-organizational implications. Thus, systematically incorporating other models that deal with reforms should integrate both organizational-structural factors and individual-mental/emotional factors into one coherent theory.

Through the prism of the institutionalism perspective, processes of institutional change begin when existing policies and institutions create negative policy feedbacks such as ineffectiveness and stakeholder dissatisfaction [55]. Such feedback may emerge due to new techno-economic revolutions and the impact of transnational forces or due to government failures and transformation of the political culture. Negative policy feedback is needed for such a change to emerge, but another important condition is a relatively weak lock-in effect. This means that pro-status-quo players and forces either do not exist or are too weak to lock in the existing policy and block change. In reality, these forces are often very strong and present significant barriers to change, and the literature offers various ways to overcome them [10,57]. This line of thinking is quite structural in nature, thus marginalizing human/indi-

vidual parameters, which are valuable inputs that may complement the explanations.

Digital government transformation is also continuously nurtured through the new digital technologies that are developed and promoted by global digital and high-tech firms. These new technologies constantly generate expectations and pressures on public administrations to make use of them across the board. However, the specific ways in which these technologies are deployed depend primarily on existing intra- and extra-organizational characteristics [58,59]. These include micro-level characteristics such as organization type and climate, internal politics and the internal labor market [60–62], and macro-level characteristics such as New Public Management (NPM) practices, globalization, political and civic culture, and socioeconomic forces [63]. The interactions between such new technologies, which are constantly infused into public spheres from the external business industry, together with the organizational characteristics of public realms create the practices and ideas that define the digital transformation. Thus, a key research challenge is to identify patterns of interactions between technology and organizations that lead to specific practices in digital transformation. For example, a highly centralized organization will most likely adopt technologies that enable control but will be less favorable towards technologies that encourage inclusion and enable participation in decision making. Indeed, Hammerschmid et al. [21] present findings that confirm earlier studies indicating that information and communication technologies tend to reinforce some traditional features of administration and the recentralization of power.

5.1.2. Digital transformation of performance: the human interface and perceptions of the DGF

Digital governance transformation influences and shapes both public policies and strategies, and public management practices and performance [64,65]. Ultimately, such policies and managerial practices are expected to reconfigure the relations between individuals and government. The magnitude and scope of such public policies and managerial practices is largely reflected in stakeholders' perceptions of the DGF. Hence, and according to our model, stakeholders' perceptions of the DGF may be affected by governments' policies and strategies, and by the public management practices resulting from those policies. These perceptions may be related to cultural diversity and should be examined through the lens of various types of populations (e.g., elderly people and younger generations, minorities, and marginalized people). Perceptions of the DGF are also expected to affect public sector performance (outcomes and processes). This may affect individuals and organizations across the public spheres in many ways. For example, public organizations may respond to the nature of the perceptions of the DGF within their internal environment, or to the nature of the perceptions of the DGF in other organizations with which they interact and collaborate. In addition, perceptions of the DGF may affect individuals inside and outside public organizations (employees, policymakers, citizens, etc.). Consequently, they may affect public sector performance in two major dimensions: (1) the effectiveness and fairness of managerial processes, and (2) the quality and quantity of public services/goods. Such public sector performance include processes and outcomes which are both subject to change in the digital sphere of governance [66]. While the NPM approach tends to focus on outcomes such as effectiveness and efficiency [9,67], more recent studies highlight the centrality of managerial processes as main determinants of citizen-government relations (Gil-García et al., 2018; [68]). Such values include accountability, responsibility, fairness, transparency, participation in decision making, and representation, all of which are increasingly affected by conventional media, social media, and other digital interfaces. Together, they have a strong impact on citizens' evaluations of government performance, satisfaction, and trust in government [22]. Analyzing transformations in EU policies on digital technology, Carlsson and Rönnblom [5] show that democratic input values in AI production are

promoted by ethical guidelines directed towards the industry, while democratic throughput, e.g., accountability and transparency, receive less attention in EU AI policy. This indicates future political implications for the ability of citizens to influence technological change and pass judgement on accountable actors. Indeed, digital transformation that yields good managerial processes may lead to improved public sector performance but can do so only through the human interface. We maintain that DGF perceptions largely reflect these human connections as they put greater emphasis on process variables instead of outcome variables [9].

Taken all together, successful digital transformation may affect DGF perceptions, and increase organizational and individual indicators of government performance in terms of processes and results. However, such relations may vary depending on individual, structural and cultural parameters. More positive perceptions of the DGF can lead to improved performance when individuals are adjusting and accepting the digital reforms in government. Digital technologies may increase transparency, enable participation in decision making, improve accountability and establish fairness in government-citizens relations. However, an important missing link in this relationship is individuals' *mental and emotional reactions (MEMOs)* to such digital transformations and to DGF perceptions. In the next section, we extend on how MEMOs serve as mediator the relationship between stakeholders' perceptions of the DGF and organizational outcomes.

5.1.3. Mental and emotional models (MEMOs): the missing link in the puzzle?

Fig. 3 presents a more detailed version of the elementary model (Fig. 2), in which various elements of each building block are expanded and interrelated. As Fig. 3 postulates, we propose that when people are confronted with the implications of digital transformation in governance (e.g., perceptions of the DGF), they process and filter them through their mental-emotional models (MEMOs). Mental models are rooted in cognitive psychology, and their principal assumption is that individuals reason by trying to envisage the various possibilities that are compatible with what they know or believe [69,70]. In complex situations, such as dealing with complex digital environments, individuals picture a scenario or moving mental images and react accordingly. Moreover, mental models are frequently associated with emotions (e.g., Ref. [71]). It is argued that mental models create emotions among individuals and trigger responses that are highly relevant to a variety of public services and outcomes. For example, Jain, Kumar, and Kumar [50] demonstrate how emotions can be detected by automatic facial recognition and suggest that these applications are highly useful for clinical and behavioral purposes. Prabhu et al. [51] point to several emotions as central to any process of HMI (e.g., happiness, sadness, anger, surprise, fear, disgust). Thus, the process of reacting to a challenging digital environment is likely to depend on, emotions, Emotional Intelligence (EI), and MEMOs. Note, however, that studies on emotions from a more psychological perspective disagree about the existence of the basic emotions that are fundamental to such reactions (e.g., Ref. [72]). Nevertheless, there is no disputing that technology arouses emotions, and that emotions resulting from mental models are highly relevant to digital governance, with manifold optional situations for interaction [39].

Recently, Gomez and Whyte [23] used a survey-based experiment to test the aftermath of cyber operations on individuals within international environments. They found that the impact of novel environmental circumstances on opinion formation is shaped by the individuals' embeddedness in modern digital society. Consequently, they argue that long-term exposure to any invasive development mitigates the emotional response associated with it. They further suggest that the unique characteristics of a development (i.e., web-technology proliferation) are important in opinion-formation, as the sensitivity to digital threats is grounded in personal threat-sensitivity. Their recommendations to

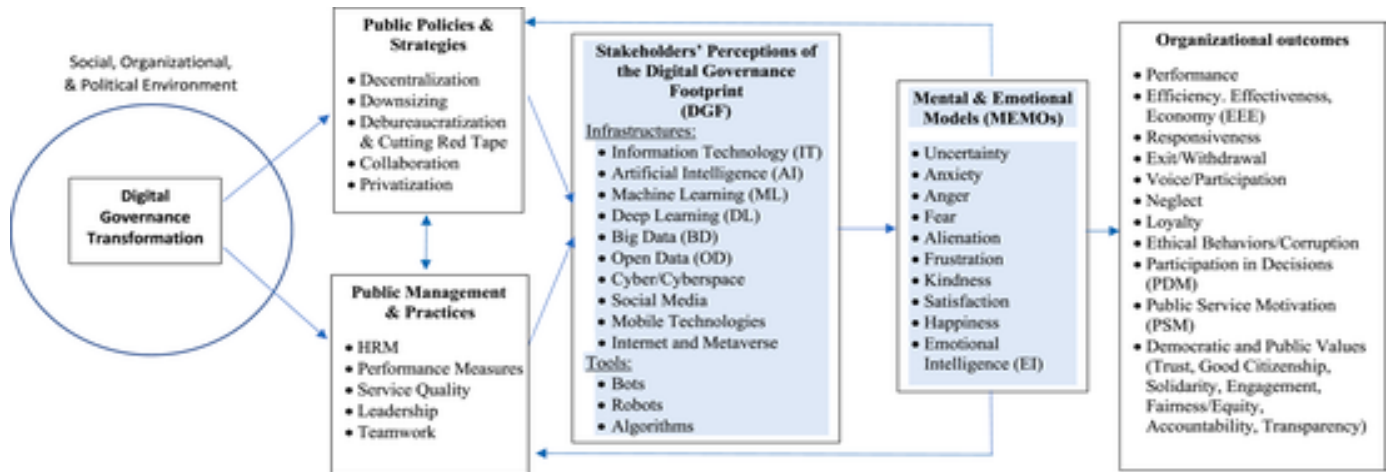


Fig. 3. An integrative model of human-machine-organization interaction in public spheres: An extended integrative model.

policymakers are to examine the outcomes of new technologies closely, as public responses may be manifested through the lens of prevailing social and political narratives (p. 1137). These findings further strengthen the idea that MEMOs are essential to better understand the impact of digital governance on individuals and on public organizations' outcomes. Individual filters may intervene in the processes of policy and managerial formation and implementation, creating biases and barriers, but also opportunities, depending on the personalities involved.

Following this rationale, we argue that MEMOs are an indispensable part of the human interface construct, leading individuals to reconsider their previous perceptions of the DGF and to respond based on such reconsideration. These responses are then used by decision makers to reshape public policies and public managerial practices, which are again adjusted using stakeholders' feedback. Yet the relationship between stakeholders' perceptions of the DGF and outcomes at both the organizational and individual levels may be mitigated through MEMOs, which are vital for understanding the model. Our set of propositions, especially P3–P6, will thus focus on the centrality of human interfaces (DGF perceptions and MEMOs).

5.1.4. The trio and its impact on public values

Over the years, digital platforms and IT were expected not only to affect people in and around organizations but also to change collective norms and values related with our democratic and liberal societies (Manoharan et al., 2021). When machines become increasingly involved in the process of public goods production and public service provision, the interface between individuals, machines and organizations becomes more crucial than ever. Thus, the growing integration of machines and data systems in governments similarly calls for growing need to investigate the normative and value-based aftermaths of interacting with machines. Individuals struggle to understand, accept, and willingly adapt to the new technological vocabulary and learn how to work with digital governance transformations. Organizations battle to be receptive of digitization and make the best use of it for the public interest. The norms and values resulting from these interactions deserve special attention.

Public values like participation, engagement, communitarianism, and good citizenship are increasingly changing vis-à-vis digital infrastructures and tools such as social media, mobile technologies, and rapid global data exchange between governmental agencies and between other partners (Meijer & Boon, 2022; [66]). Perceptions of DGF and MEMOs may thus be understood as a vehicle on the way to define new democratic values. Such values are increasingly shaped by digital

platforms of social media which allow more voice and activism of individuals and better capacities to create effective interest groups and collective pressure on governments to initiate reforms, change policies and strategies (e.g., Ref. [22]). The creation of networks and collective action in and around public organizations increases public impact on governance, which alters the entire democratic ethos in modern states. It fosters a spontaneous and authentic discourse with greater sensitivity and flexible nature as embedded in digital tools.

As the digital evolution turns to be a full-scale revolution it is expected to foster a more equal, humanized, advanced, and public-value oriented governance. To meet such goals, we must use behavioral knowledge, methodologies, and experience and integrate them with machines, algorithms, and information bases that are digitally controlled and monitored. Theories of "good governance" (e.g., Kaufmann & Lafarre, 2020), "new public governance" and the "co-production of services" (e.g., Sorrentino, Sicilia, & Howlett, 2018) will have to adjust by balancing the trio impact of human-machine-organization and the interactions between them as a major key for changing values in public spheres.

5.1.5. Inside the black boxes: potential propositions

As suggested so far, the idea of human-machine-organization interaction in digital governance facilitates new conceptualization, terminologies, perspectives, and an overall rich ground for theoretical, methodological, and empirical progress. An initial set of propositions stems from this idea and highlights several competing relationships. We list six major propositions that draw substance from the rational developed so far. Note however that these propositions are obviously only partial reflection of potential interactions and thus should be taken primarily as directions for additional contributions.

P1. Digital government transformation, organizational outcomes, and individual reactions are subject to changes in the social, organizational, and political environment.

P2. Digital government transformation affects public policies and strategies (e.g., decentralization, downsizing, debureaucratization and cutting red tape, collaboration, and privatization).

P3. Digital government transformation affects public management practices (e.g., human resource management practices, performance measures, service quality, leadership, and teamwork).

P4. The human interface is based on stakeholders' perceptions of the digital governance footprint (DGF) and on the mental and emotional models (MEMOs) of individuals. These mediate the relationship be-

tween digital transformation in government and public organizations' outcomes and performance.

P5. Public policies and strategies, and public management practices mediate the relationship between digital governance transformation and the human interface (stakeholders' perceptions of the DGF and MEMOs).

P6. MEMOs (e.g., anxiety, anger, fear, alienation, frustration, etc.) mediate the relationship between stakeholders' perceptions of the DGF and organizational outcomes (e.g., performance, efficiency, effectiveness, economy, exit/withdraw, voice/participation, neglect, loyalty, ethical behavior, PDM, PSM, and other democratic values).

These propositions are general and may be formulated in more specific ways for dealing with the specific variables in each building block. This calls for serious effort of scholars from interdisciplinary orientations that may be interested in the psychological, political, sociological, administrative, managerial, technological, and environmental fields. Yet the real challenge is integration of the accumulated knowledge into a holistic view where the science of governance and public management may benefit from such collaboration. To meet these goals a wide range of methodologies and empirical settings should be employed. The next section tries to point to some of these methodological platforms.

5.2. Potential methodologies

The methodologies available to carry out such tasks are many. We will focus on those that in our view are the most promising, beneficial, and up to date in such studies: (1) process-tracing (within-cases) methodology, (2) comparative (between-cases) methodology, and (3) surveys, surveys/conjoint-experiments, and lab-experiments.

Process-tracing (within-cases) methodology is usually defined as the systematic examination of diagnostic evidence selected and analyzed in light of research questions and hypotheses posed by the investigator [73–75]. Process tracing is an analytical tool for drawing descriptive and causal inferences from diagnostic pieces of evidence – often understood as part of a temporal sequence of events or phenomena. By engaging closely with cases and accumulating fine-grained case-specific data, process tracing can make decisive contributions to diverse research objectives such as (a) identifying novel political and social phenomena and describing them systematically, (b) evaluating prior explanatory hypotheses, discovering new hypotheses, and assessing these new causal claims, (c) gaining insight into causal mechanisms, and (d) providing an alternative means – compared with conventional regression analysis and inference based on statistical models – of addressing challenging problems such as reciprocal causation, spuriousness, and selection bias. Thus, qualitative tools that can strengthen causal inference in small-N designs based on the matching and contrasting of cases–designs. This strategy has great value for studying human-machine-organization interactions, but its contribution to causal inference urgently needs to be supplemented by within-case analysis. Hence, the process tracing methodology can be applied for the purposes of within-case analysis of the digital transformation's initial stage and perhaps its impact on policy formation and management practices. Furthermore, by choosing representative cases based on inter-sector and international comparisons, we will be able to identify general patterns of relations between organizational characteristics and the adoption of digital technologies in the public sector.

Comparative (between-cases) methodology will be used to examine social, political, and cultural differences in the human-machine-organization interactions. These may be valuable for better understanding the differences between nations, cultures, and societies when it comes to dealing with the digital governance challenge. It may also contribute by facilitating a comparison between different public agencies, sectors within governments, and the federal-state-local differences. This methodology has been developed and applied in the con-

text of comparative public administration ([56]; Raadschelders et al., 2015). Fitzpatrick et al. [76] present the results of a content analysis of 151 comparative public administration articles from 2000 to 2009. They recommend enhanced application of mixed methods, increased use of culture and values as key concepts, and integration of a broad range of social sciences to encourage more students, practitioners, and scholars to think and work comparatively. We agree that this comparative approach may be highly valuable as the type of machines (technology), humans (social groups), and organizations (a variety of public agencies) differ but are nonetheless intercorrelated. Cases for the comparative analysis should be chosen after careful review of the literature and based on past studies' results.

Surveys, survey/conjoint-experiments, and laboratory-experiments are especially important in studies of human interfaces. In the field of government and public management studies they gain even higher recognition with new ways to monitor individuals' responses to external impacts of the digital impact by various types of machines and algorithms. Thus, they should be at the heart of quantitative analysis of human-machine-organization interactions. Whereas surveys are a very commonly used method in the discipline, survey experiments (e.g., conjoint experiments) and especially laboratory experiments are less prevalent. Nonetheless, they have become more and more widespread in recent years ([77], part III). They may be essential and useful in such studies as they allow close examination of both stakeholders' perceptions of the DGF and subjective aspects of MEMOs (e.g., Ref. [10]). Appropriate survey tools should be developed to assess perceptions of the DGF. This should be done based on past established measures/experience in applied psychology, organizational behavior, and environmental science that employed Ecological Footprint scales, and mental/emotion recognition tools rooted in cognitive psychology (e.g., Ref. [72]). The new tools should be tested for validity and reliability among different public stakeholders (e.g., policymakers at the central and local governance, citizens). In addition, survey-based and lab-based experiments are needed to gather objective data on individuals' mental and emotional models as a reaction to digital governance transformations. Survey experiments (e.g., conjoint experiments settings; [78]) may be used to control for data-driven government impacts on individuals, along with laboratory experimental methods based on at least one research group and one control group (for every type of stakeholders group), where only the former will be exposed to greater digital transformation impacts. These experiments have previously been suggested and used in the discipline (e.g., Ref. [79,80]) and promoted by laboratories across the world. Studies should focus on identifying different digital practices that may influence perceptions of the DGF and participants' emotional responses. Additional surveys and survey experiments should be developed to try to trace the impact of the human interface (DGF perceptions and emotional responses) on the organizational processes and outcomes in the forms of performance, perceived performance, and public values. Merging the experimental/behavioral approach in public management with the idea of digital public management and governance is therefore a promising methodological advance for developing this field (e.g., Ref. [81,82]).

5.3. Quo-Vadis? Discussion

The digital governance revolution is here to stay. Its footprints are well recognized today, but its magnitude, scope, and impact on science and on societies will become far reaching in the coming decades (Simone, 2022). Is this the end of authentic human-based governance and the beginning of an artificial/synthetic era in public service? In what way will it affect government decisions and citizens' life? Are machines only the first signal of an emotionally dwindling governance age or, alternatively, there are better ways to integrate humans' emotions with machines' impact? What are the challenges and risks waiting for public

managers and for decision makers in face of greater algorithmic and machinery dominance? and what role do citizens and civic servants have in such trends, if any? Finally, how do scientists and intellectuals contribute to this inevitable process?

The goal of this paper was to theoretically deal with only some of these questions. By offering an integrative model of human-machine-organization interaction in public management we also seek to point to potential methodological and empirical progress. We explained how digital transformation may affect policies and managerial practices, and later affect perceptions of the DGF and MEMOs among individuals. All these may have a sustainable impact on public organizations outcomes, performance, and values. Consequently, we argued that better understanding human interfaces such as perceptions of the DGF and MEMOs may help to adjust procedures, routines, human resource management tools, and other interactions with government during the digital revolution.

The human interface is central as it plays a prominent mediating role between machines and organizations. For example, citizens may believe that various technologies threaten their privacy and hence be suspicious and reluctant to use them. As a result, they may even develop anger and anxiety with greater political and democratic implications. Such reactions intensify in times of crises and emergencies when both citizens and governments suffer uncertainty and greater stress and strain. On the other hand, digital platforms may improve accessibility to information and improve social equity, feelings of fairness, happiness, and kindness [68]. Hence, these complex dynamics lead to another challenge; finding patterns and contingencies in which MEMOs mediate (or perhaps moderate) the relations between perceptions of DGF and public organizations outcomes and performance. Another research challenge is to track the routes and patterns of influence that MEMOs have in the mechanisms leading to digital transformation. Nonetheless, our model should not be taken as a rigid framework but rather, as a flexible port of departure for further interest by scientists, policy makers and other stakeholders in public spheres, those who are concerned with the impact of new technologies on public management and governance.

The centrality of this impact cannot be underestimated, especially vis-à-vis the lessons learned from the COVID-19 global pandemic, and the way it changed our societies. This crisis exemplified the impact of digitization on governments, on citizens and on public organizations in the most blatant way. Almost out of nowhere, a pandemic erupted and highlighted major dilemmas in the interchange between individuals, machines and technology, and public organizations. It is already obvious today that major drawbacks in public management theories and knowledge have affected and intensified the global coronavirus pandemic crisis (e.g., Young, Wiley, & Searing, 2020), and that technology was there in a way we have never experienced before. Examples include the miscalculation of the potential risks caused by use of advanced technologies, and lack of strategic plans to better integrate technological tools and knowledge with human mental and emotional needs and expectations. During the COVID-19 crisis, digital tools, IT, algorithms, and machines offered indispensable mechanisms for prevention and treatments, tracking the progress of the pandemic, assessing its impact, and taking real-time policy decisions. New technologies greatly affected governments policies towards vulnerable populations and were crucial in changing individuals' attitudes and behaviors to prevent greater damage. Yet, digital governance turns to be a major tool for dealing not only with such major public healthcare issues, but also with some other pressing problems in modern nations (e.g., public education, welfare, crime prevention, public transportation, smart cities, to name only few). Consequently, we argue that this digitized and e-governance era calls for integrative theories and models with better balance between humans, machines, and organizations in all public domains. This balance is important for theoretical maturity in science, but also for practical policies and for managerial reasons. Its centrality builds on calls for

greater responsibility of public agencies and public players to citizens as partners in the governance process, and on the strive for greater stability and sustainability of democracies [66]. Better dealing with such epic crises in the future must also consider threats to democracy and values of the free society. All this becomes even more challenging during a digital revolution of new and fake news, the questionable preparations of policy makers to future catastrophes, the lack of international coordination and collaboration, and the overall cognitive bias in managerial decisions before and during the battle for public health. It became clear that the interactions between governments and citizens can be both improved or endangered by new machines and technologies. Therefore, to minimize damage to the lives of millions and the health of even larger numbers of individuals in upcoming similar crises, new models of integration should be developed and examined.

Table 1 summarizes the major contribution of this paper and its implications for theory, research, policy and practice of DG. We believe that these implications will contribute to the external validity of the model and the propositions by encouraging empirical studies in various public sector settings and among various public stakeholders. Recently, Rona-Tas (2020, p. 905) suggests that algorithmic governance is "the replacement of social institutions and processes with algorithmic decision making". Novel ideas of governments by virtual reality and meta-verse inspire theoretical and empirical studies, as well as practical innovations in government management at local, state, and federal levels (e.g., Ref. [12,64]; Bayat & Kawalek, 2021). However, even at this stage, integrative empirical studies on the use of modern technology in governance and in other markets argue that we are still far from a situation of machine monopoly. Algorithms and computers cannot fully replace human intelligence, mental and emotional capacities. Human components remain crucial in the process of public goods production and service delivery. Social cues, narratives, values, norms, and psychological perspectives are constantly 'folded' into governments and markets in various forms (Muniesa, 2007). Thus, even during the third wave of digitization in governance many challenges are posed to policy makers and civic servants, to citizens and to other stakeholders by continuously changing the borders of responsibility in public realms. This is exactly where HMI meets public management and governance, and questions on the interface between machines, humans, and public organizations become more relevant than ever.

6. Summary

Theories on such interactions in public management are at initial stages (e.g., Kattel et al., 2020) but become increasingly essential not just from the technological and engineering perspective (e.g., what makes these interactions better, smoother, and more effective) but also form the social and administrative perspective (why, how, and when such interactions make a difference for individuals and organizations? Can they explain public organizational outcomes and individuals' reaction? Do they matter for improving public policies, enhancing public goods and services, and fostering more intelligent governance?). This paper tried to suggest that digital governance may be seen as a double-edge sword. It may have a constructive impact on performance, efficiency, and values in governance. But it may also pose problems and dilemmas, such as interface problems, ethical issues, and the cost of adaptation and readaptation (Dunleavey et al., 2006; e.g., Dobrolyubova, 2021). It is thus suggested that the human interface may be a missing link with the greatest impact on the outcomes of digitization in governance.

Uncited references

[83]; [84]; [85]; [86]; [87]; [88]; [89]; [90].

Table 1
Key implication.

Implications	Theory	Research	Policy and Practice
1	DG transformations are subject to changes in the social, organizational, and political environment. They affect public management (e.g., decentralization, downsizing government, de-bureaucratization and cutting red tape, collaboration, and privatization dynamics).	Empirical designs based on mixed-method analysis should look for testable models on the link between digitization and reforms in governance and in public management	DG transformation affects practical public management. Decisions and managerial practices at the federal, national, and local levels should incorporate digital tools and recognize both their advantages and risks.
2	DG transformation relates to managerial theories at the human-individual and social-organizational levels. An integrative theory of DG is essential and must lead to empirical studies.	Empirical studies should integrate knowledge, methods, and tools from multi-level sources (human-individual, social-organizational, and digital-machines). Empirical studies should involve multi-level, and mixed-methods designs	DG policies and practices are relevant for human resource management, performance measures, service quality, leadership, and teamwork initiatives. Governance policies and practices must encourage collaboration of experts with multiples POVs
3	Digital Governance Footprint (DGF) is an essential component for theory development.	Validate the meaning of DGF and test its potential mediating/moderating role	DG leaves its footprint in any policy, practice, and decision related to governance.
4	Mental and Emotional Models (MEMOs) at the human-individual level may be a missing link in developing integrative theory of DG.	Test the mediating role of MEMOs	Emotions in the context of DG are a major part of the DG transformation process. Strategic decision making should put them at the centre of reforms and change
5	Integrative theory of DG transformation should be supported by rigorous and advanced methodology	The most promising empirical avenues are: (1) process-tracing (within-cases) methodology, (2) comparative (between-cases) methodology, and (3) surveys, surveys/conjoint-experiments, and lab-experiments.	Policies and practices related with DG transformation must be strongly rooted in reliable empirical research.

CRedit authorship contribution statement

Eran Vigoda-Gadot: Conceptualization, Investigation, Methodology, Project administration, Resources, Visualization, Writing – original draft, Writing – review & editing. **Shlomo Mizrahi:** Conceptualization, Investigation, Methodology, Resources, Visualization, Writing – original draft, Writing – review & editing.

Data availability

No data was used for the research described in the article.

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