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Enhancing E-Government Proactive Services Through Advanced Data Processing Technologies

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Abstract

The approach of citizens to the digital world allows the public sector to provide services that cross the frontiers of traditional citizen-administration relationships. Anticipating consumer needs, fostering more satisfying relationships, and reducing resolution times are some of the goals for a new era of electronic public sector services. A concise set of proactive systems is compiled to illustrate and analyse these options. This paper focuses on analysing the key role of Big Data and Digital Twin in public administrations as tools for providing Proactive Services (PAS). It is common for government administration to consider the use of disruptive technologies to enhance services designed to improve relationships with citizens. This paper explores the use of innovative technologies to increase the number of proactive services available within public administration (Proactive Public Services - PPS), the challenges they face, and the technical limitations that arise. A change in mindset is necessary. Paraphrasing an illustrious United States president in his inaugural address: "*Ask not what citizens can do for administration – ask what administration can do for its citizens*."

Keywords: Big Data, Government services, Proactive, Decision making

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Introduction

Life is full of events that require administrative services, such as being born, going to school, graduating, obtaining a driver's license, starting a job, getting married, having a child, or starting a new activity or company. Sometimes, public administration creates services to assist citizens with these life events.

A primary goal is to provide an overview of how data-driven public services could become a source of knowledge for policymaking. Another goal is to justify the use of proactive services as the best way to communicate with citizens, based on big data usage. Digital governance has improved public service provision over several years. The first era focused on transferring paper-based system into digital domain using holistic solutions. A second era of digital governance era is currently underway, enabling more effective policies. Data-driven policies in this era implement better individualized, tailor-made services with improved process efficiency and higher citizen satisfaction.

In the first era, it was common for public administrations to offer services through reactive tasks, improving public services by replacing paper-based systems. Managers created digital forms as a direct replacement for physical ones. While this digitalization sometimes helped with form completion, it also increased the amount of information required. The new era of digital governance enables individualization and tailor-made services, yielding better process efficiency and greater citizen satisfaction. Authors such as Tan and Crompvoets (2022) discuss the transition from e-government to a new era of digital governance. However, interactive services have not yet fully realized their potential. In some cases, the concept of “Digital Neo-Weberianism" has been suggested as a new approach to shaping interactions between citizens and governments This concept mirrors the first era but utilizes more advanced forms.

A data-driven government capable of proactively using and delivering information to its clients represents the next generation of governance. Lemke et al. (2020) argue that “designing proactive services of e-governance should be seen as the next stage in service design for e-governance."

Organizational and cultural condition are evolving from an “electronic government” paradigm to a “digital governance” paradigm (Omar et al., 2020). Strategies for implementing digital governance include transitioning from a reactive to a proactive approach in public policy and service provision (Dias & Gomes, 2021). This shift also involves moving from an information-centric government to a data-driven public sector and toward a user-driven administration.

There are also regulatory limitations to consider. Certain legislative guarantees restrict data processing possibilities, such as those in the European

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Union. Legal challenges may arise with proactive services based on automated decision-making. For instance, European legislation recognizes the right not to present the same documentation multiple times, though in practice, data is still frequently requested repeatedly.

According to Velasco (2020), Article 22 of Regulation (EU) 2016/679 of the European Parliament and of the Council states, "The data subject shall have the right not to be subject to a decision based solely on automated processing, including profiling, which produces legal effects concerning him or her or similarly significantly affects him or her." This requires human intervention in decision-making, allowing individuals to challenge such decisions or make allegations.

Efforts to promote openness and collaboration with Trans-Atlantic countries, such as the data processing agreements between the US and Europe, are ongoing. While attempts like Safe Harbour (2000) and Privacy Shield (2016) have not produced satisfactory results, negotiations continue with the EU-US Data Privacy Framework (EU-US DPF) to establish a robust data processing framework.

Some authors have emphasised the need to design public services around citizens rather than providers. Tailoring services to meet the needs of citizens, businesses, and other actors involved in e-government is critical. Henriques et al. (2019) present a clear list of twelve life events in the context of public services that can be monitored, including birth, marriage, divorce, issuance/renewal of a citizen's card or passport, enrollment in public school, parental benefits/family allowances, associating a household with a family doctor, vaccination/family planning, issuance/renewal of a driver's license, registration of vehicles or buildings, taxes, unemployment, and retirement.

Public services must adapt to changes brought by new generations and increased mobility. In the European Union, only 6% of proactive public services (PPS) are supplied proactively compared to 81% of government services accessible online (Barasa & Iosad, 2002). A proactive governance model has the potential to transform the relationship between citizens and governments. Speed and simplicity, key benefits of proactivity, improve perceptions of government services (Baig et al., 2014).

Proactive services have long been used in sales systems. Strategies like cross-selling and up-selling, based on product data and history, aim to enhance sales and improve the buyer experience. A new stage of government is emerging to meet the increasing demand for e-services on mobile devices and for data-driven governance capable of proactively serving citizens and enterprises. This transition requires a new framework to define the maturity of governments moving from e-government (eGov) to smart government (sGov) (Lemke et al., 2020). Foundational frameworks for analysing stage models have been presented by various authors, including Hiller and Bélanger (2001),

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Andersen and Henriksen (2006), and Klievink and Janssen (2008). These models have shaped the understanding needed to develop stage model extensions for novel and innovative governance that is primarily data-driven and proactive.

Proactive services benefit not only citizens but also businesses, organizations, and society by reducing administrative burdens.

Laney (2001) defined Big Data by its volume, velocity, and variety. Governments view Big Data as a means of addressing national challenges in areas like the economy and healthcare (Kim et al., 2014). Big Data revolutionizes public administration through systems for producing, collecting, storing, and analysing vast amounts of data (Clark & Golder, 2015). Big data methods include data aggregation, extraction, pattern detection, network analytics, and predictive modeling. Public administrations are still learning to harness Big Data as a development tool (Isaza & Zarate, 2021). Challenges arise when integrating public services with data to create innovative solutions. Leoni et al. (2023) highlight the importance of collecting non-traditional data sources, such as digital interactions, remote sensing, satellite data, tollbooth cameras, and open data sources.

Digital twins have been proposed for technology governance (Husni et al., 2022; Proper et al., 2021). Kopponen et al. (2022) proposed a digital twin model for citizens, while Lasse (2020) presented classifications of digital twins along lifecycle phases, common uses, and hierarchical levels. Proactive services could accommodate various digital twin models.

Temkin Goup (2011) introduced the "Six Levels of Proactive Support" (Ignore, React, Alert, Self-Heal, Pre-Empt, Avoid), which categorize proactive support and integrate multiple criteria. This framework has since been adapted for public services.

What is Proactive Service?

Proactive Computing is not a new area, Tennenhouse (2000) described proactive computing, but nowadays, scientific researchers have not yet provided dedicated PAS literature (Hhasmammadli & Erlenheim, 2022). One way to reduce this gap is to create a comprehensive taxonomy. Services can be categorized into two types based on who makes the first move: Proactive or Reactive.

Reactive customer service, as described by Brown (2022), "is when a customer has to reach out to a company representative." The same author defines proactive service as "anticipating customer needs and actively reaching out with a solution, whether by communicating a potential problem that has cropped up or allowing customers to self-service their issue." Henriques et al. (2019) define proactive services as "... an automatic provision of services, without the need to wait for a citizen." Another definition by

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Khasmammadli (2023) refers to a service provision model in which governments anticipate citizens' needs and provide a service before citizens request it. This must occur at the exact moment -not too early or too late- anticipating events or responding after an event.

Perfect customer service must ensure perfect timing with proactive customer service. This does not imply personalization for every customer: "Proactivity and customization are independent and do not necessarily go hand in hand" (Andersen & Henriksen, 2006).

Not only customer or citizen relations can be classified, but sharing data with other organizations or notifying changes within one's organization can also be proactive. In this context, data interchange/communication must be initiated by the producer, while the consumer only waits to receive the data.

Proactive models react to various stimuli. Instead of reacting to citizens' request, they react to regulations, policies, or changes in data. Depending on the perspective, services can be classified as reactive or proactive from the citizen's viewpoint. However, from another viewpoint (such as that of analysts or politicians), they are conditioned to events. These events could include increases, changes, or stability. They do not act independently but are triggered by data changes, not citizens' actions.

A new definition is proposed: Proactive services are those that flexibly react to data changes, while reactive services respond only to citizens' action. Proactive services might be more efficient compared to reactive services.

Proactive services must be periodically evaluated due to the changing characteristics of data. Consequently, data volume increases dramatically when settings must be evaluated at multiple time points.

Some authors such as Lemke et al. (2020), have written about a new state of e-government (eGov) proactive government decision-making maturity, which has emerged "due to the involvement of Big Data and data analytics."

Are proactive services better than reactive services? The following tips may help balance reactive and proactive approaches. The first tip is based on higher productivity in processes designed proactively. The next tip is a higher service revenue, which, in public administrations, must be interpreted as citizen satisfaction. Lastly, there is an increase in satisfaction and loyalty scores.

Martinez et al. (2020) propose a classification for the degree of personalization, but a new classification is proposed based on the following categories:

- **Duties-based:** Assistance with various types of duties, such as tax obligations, labour obligations, contractual duties, or financial liabilities.

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- **Procedures-based:** Periodic reporting on the status of procedures or matters of concern.
- **Profile-based:** Automated granting of social benefits or aid based on the profile of a person, family, or community.

The existence of authenticated means of communication with sufficient guarantees is necessary (e.g., email, WhatsApp, Telegram, Signal, citizen's boxes, etc.). While many entities consider a cell phone or email sufficient for communications and administration, this is not yet the case in public administration. Proactive services not only involve external stakeholders but can also benefit internal stakeholders. Alarm or advisory systems can be implemented using similar approaches to notify public servants to take appropriate measures.
Reactive services suffer from long lead times due to the numerous steps required before resolution or conclusion. Focusing on an event (customer request or event trigger), a figure with multiple cases of services is proposed.

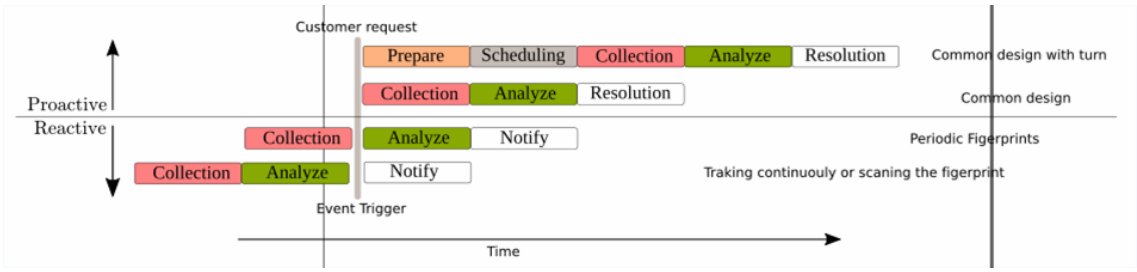

Figure 1. Proactive and Reactive services steps

The process begins by preparing the creation of laws and regulations necessary to achieve government goals. Scheduling involves setting aside time in the day to make presentations. Collection entails gathering the necessary data for the intended purpose. Next, the collected data is analysed, and any identified issues are subsequently resolved. Notification, similar to resolution, involves informing relevant stakeholders about the outcomes; however, this step focuses solely on delivering notifications.

Certain administrative functions must be defined for proactive services: supervision, regulation, or service delivery (Laney, 2001). Services categorized as proactive typically have no endpoint. Processes or tasks involve testing a condition or waiting for an event to trigger a response. Processes designed to run only once are executed as a response to a political event (see topology in planner strategy criteria).

For instance, assisting homeless individuals does not require evaluating personal profiles or examining social exclusion profiles. Instead, it entails providing proactive citizen services based on public administration

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data. As long as this approach is not the sole method for obtaining benefits, it should not pose a legal problem.

At times, the passage of legislation mandates include information regarding the economic expenditures necessary to carry out the actions outlined within the regulation. To create this economic assessment, it is essential to evaluate the quantity and target nature of the projected consequences. Previously, such an assessment needed to be published compulsorily alongside the draft act. This approach enhances the effectiveness of lawmaking and improves the outcomes of law production.

Implementing proactive services presents a new challenge for government structures. Legal and technological teams must approach this area carefully, as a mistake could lead an organization into unexpected situations. Developing regulations to authorize proactive services requires experienced personnel in law. Meanwhile, analysing historical data to provide insights for drafting laws is the responsibility of skilled data analysts.

Examples

The effectiveness of proactive services can best be understood through examples. Below are several cases illustrating proactive and reactive services, along with ways to transition between them. Some proactive services may also incorporate reactive elements.

- PAS#1: As described by Khasmammadli (2023) and Hhasmammadli and Erlenheim, (2022), various user cases demonstrate the potential for these types of services. Advanced data analytics, for example, can identify citizens at risk of poverty or financial distress, enabling proactive e-service to assist them before difficulties arise. Another example involves analysing housing data to identify citizens facing housing instability or homelessness and providing proactive assistance such as rental subsidies or support services. Lastly, improving the lives of parents by creating a proactive service for childbirth allowances has been exemplified in Azerbaijan, as shown in Figure 2.

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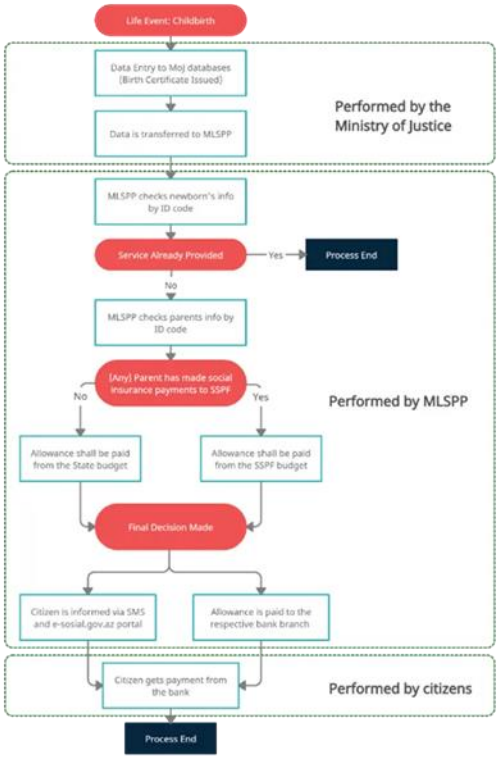

Figure 2. From the Ministry of Labour and Social Protection of Azerbaijan (Khasmammadli, 2023; Hhasmammadli & Erlenheim, 2022)

- PAS#2: The Spanish government has introduced a cultural wallet initiative for young individuals who turn 18 in 2023. This service promotes access to cultural services in Spain. Currently, young people must actively apply for the wallet by filling out a web form and waiting for it to be processed, a process that may take several months or even years. A proactive service would automatically provide wallets ready for use to all individuals born in 2025, eliminating the need for an application.
- PAS#3: The Portuguese government offers a Social Energy Tariff by integrating data from energy companies, tax authorities, and the social security system. By combining data from these sources, the government can automatically provide eligible individuals with an energy tariff tailored to their social circumstances.
- PAS#4: In multiple countries, such as the UK, the Netherlands, and Spain, annual tax returns are pre-filled with existing information. Citizens are required only to review, accept, or correct the information before submitting their return.

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- PAS#5: A recommendation system is a proposal for a reactive service where, based on a user's profile, a web platform proactively recommends products or services tailored to their preferences and characteristics.

Proactive Services Taxonomy

Building on the work of Lasse (2020) and the Temkin Group (2011) mentioned in the introduction, a new taxonomy is proposed based on multiple criteria. This taxonomy aims to be simple and clearly defined, providing an accessible framework for both users and developers. It fosters better understanding and clarity in defining and implementing proactive services.

Table A. Taxonomy for proactive services

Relationship	Criteria	Options
Related to trigger	Decision position on time	Anticipate, Recognize
	Planner strategy	Continuous, Periodically, Sometimes, Triggered by event
	Trigger type	Data, time, location, status, revenue, etc.
Related to data	Data used	Citizen data, External data, Mixed
	Personalization level	Personalized, Grouped
	Facts	Duties, Procedures, Profiles
Related to Results	Outcomes	Solve, Notice
	Profits	For citizen, for service provider, third person
Related to Technology	Processing	Emulated, simulated, IA, Digital Twin, etc...
	Notify system	Mail, SMS, messaging app, etc.
Related to entitlement	Authorized by law	Laws, directives, Decisions, Recommendations, Regulation, etc.
	Company Strategic alignment	Goals, targets, objectives, corporative aims, aspirations

- Related to the Moment to Start the Event
  - Based on the Decision Position on Time: Refers to the timing of decision making. This can involve either anticipating a decision with a predictive model or waiting for an event to occur and recognizing previously defined options (Anticipate or Recognize).
  - Based on the Planner's Strategy: Includes continuous evaluation, periodic evaluation that runs after an earlier cycle, or actions executed by human intervention or triggered by specific conditions (Continuous, Periodically, Sometimes, Triggered byan event).
  - Based on the Trigger Type: A trigger based on a specific date activates when the designated day arrives. Other triggers may rely on planner strategies, such as data, time, location, status, or revenue (Data, Time, Location, Status, Revenue, etc.).
- Related to Data Used in the Process

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- Based on Data Used: Refers to the type of information employed in the procedure. Citizen data involves information directly provided via forms or administrative relations. External data refers to information not directly supplied by individuals, such as open data or purchased datasets. The mixed approach combines all available data (Citizen Data, External Data, Mixed).
- Based on Personalization Level: Determines whether the service is designed for a single individual or a group of people (Personalized, Grouped).
- Based on Facts: Refers to the previously mentioned categories (Duties, Procedures, Profiles).

- Related to Results or Effects
- Based on Outcomes: Indicates whether the service resolves the issue or simply notifies the relevant parties of a possible situation (Solve, Notice).
- Based on Profit: Identifies the primary beneficiary of the service—citizens, the service provider (e.g., the administration), or a third party (For Citizen, For Service Provider, Third Party).
- Related to Technology
- Based on Technologies: Observe the technologies employed in implementation (Emulated, Simulated, IA, Digital Twin, etc.)
- Based on the Notification System: Refers to the method used to communicate with citizens (Mail, SMS, Messaging Apps, Feeds, etc.).
- Related to Entitlement
- Authorized by Law: Involves regulations or legal rules permitting the implementation of the service (Laws, Regulations, etc.).
- Company Strategic Alignment: Refers to internal decisions aimed at achieving a common objective (Goals or Targets).

These twelve alternatives encompass nearly all proactive services deployed and help to explain the characteristics of their implementation.

Creating Interactive E-services

At first glance, proactive services and the data universe are closely related concepts. Running proactive services requires substantial amounts of data, which can be obtained from government services, open sources, or purchased datasets. Before acquiring data, it is essential to define a model to assemble each component. After data acquisition, phases for creation must be clearly defined. A new model and a four-phase guide are proposed for this purpose.

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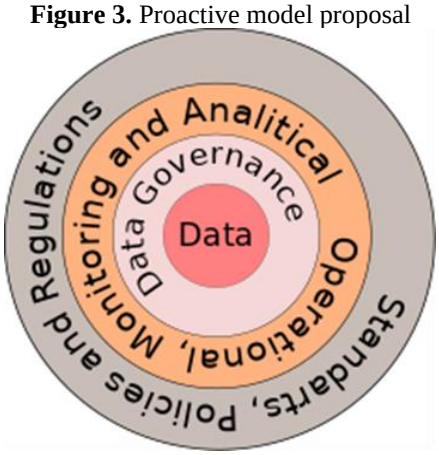
Proactive Services Model

The proposed model for proactive services consists of four well-established layers:

- Data – Incorporates all data sources and methods of data interchange.
- Data Governance – Establishes standards for the ethical and efficient use of data.
- Use of Data – Applies data for operational, monitoring, or analytical purposes.
- Use Governance – Implements standards, policies, and regulations to ensure effective data utilisation.

The four-level model, illustrated in Figure 3, offers a concise framework connecting proactive services with non-proactive services.

Figure 3. Proactive model proposal



1. Data is the core of PAS. Data-driven analysis relies on information gathered from various sources.
2. Data Governance: Several crucial requirements associated with proactive services, alongside many other domains, include Data Governance to improve data quality for service delivery. Establishing effective communication channels for reporting, notifying, or advising citizens about relevant issues is also necessary. Ensuring data quality is imperative, with features such as Interoperability and consistent records (e.g., digital IDs) being indispensable. However, challenges arise when collecting data from multiple sources, such as a lack of homogeneity.
3. Operational Monitoring and Analytics: This involves using data for operational purposes, monitoring, and analytical processing.
4. Standards, Policies, and Regulations: These encompass all work carried out to ensure that proactive services are governed effectively.

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Proactive Services Creation Phases

Some proposals have been made to create interactive e-services. One such proposal, by Erlenheim (2019), outlines a step-by-step process for proactive service creation: defining stakeholders, clarifying requirements, prototyping solutions, and finally launching the service. A four-stage definition for creating proactive services is proposed:

1. Establishing the Terms: Define the terms, laws, rules, conditions, and regulatory frameworks that will enable beneficiaries to receive the service.
2. Data Gathering: Collect data from various sources.
3. Technology Utilization: Use technology to define and combine data through an intelligence engine, employing advanced techniques such as analytics, data mining, digital twin, and AI.
4. Service Utilization: Implement the service, ensuring it is useful and usable.

In public administration environments, the first phase is particularly important. Points 2 and 3 can be repeated until a solution is obtained. The final phase involves informing stakeholders.

Joining Proactive Service and Data Universe

As noted by the authors, decision-making based on Big Data will allow proactive service to citizens (Sun et al., 2020; Lemke et al., 2020). A comprehensive suite of technologies to facilitate the creation of proactive services is proposed. This approach leverages key data technologies in two critical areas, both of which have demonstrated efficacy:

- Big Data Frameworks: Technologies such as Apache Hadoop (Hadoop, 2023), Apache Storm (Storm, 2024), and Apache Spark (Spark, 2024) are essential. Whether using batch or streaming processing, these frameworks are effective in achieving proactive services.
- Digital Twin and AI: Creating a digital twin of a citizen allows for the evolution of physical status and evaluation of future conditions, needs, and feasible solutions. With the current state, a digital twin can assess potential future states for an individual.

A definition of the digital twin, proposed by Kopponen et al. (2022) is "*a virtual representation that serves as the real-time digital counterpart of a physical object or process.*" While digital human twins (HDT) in healthcare focus on disease prevention and medical image processing, the goal is to develop a digital citizen twin. However, this area is beyond the scope of this document.

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Certain behaviour of digital twins must be guided by Influence Engineering (IE) (Sajid, 2023). This involves developing algorithms using behavioural science techniques to automate aspects of digital life. Common techniques include sentiment analysis, which categorizes user data as positive, negative, or neutral, facial expression recognition, and voice analysis to detect emotions.

Implementing Big Data in this context presents challenges, particularly regarding security and privacy. Government agencies must apply measures to manage security and privacy while sharing data, a concept known as smart governance (Sarker et al., 2018).

Threats

Addressing the risks involved in using proactive services is critical. Every project encounters risks that can be mitigated. The risk of error in Big Data models is high and context-specific. A case in the Netherlands illustrates this risk. Thousands of families were wrongly profiled as fraudulent and instructed to repay child welfare subsidies for a PAS, leading to the Cabinet's resignation (Roobeek et al., 2021).

The use of proactive services (PAS) may lead to the following risks, among others:

- Privacy concerns: Public administration functions aim to create and improve a fair society.
- Software errors: These can have dramatic consequences due to the proactive nature of the services.
- Data quality: Issues such as incorrect phone numbers, the number of intermediaries, etc., are common concerns. Significant investment in data quality is essential.
- Misinterpretation of data.
- Barriers to entry: Disadvantaged groups may lack access.
- Resistance to change: Habits are difficult to break, and vested interest persist.
- Political and religious challenges: These create additional barriers.
- Economic considerations: Low-cost technologies may not always be attractive to firms.
- Potential discrimination: There is a risk of discriminatory practices from the use of such services.

Conclusion

First and foremost, a fundamental question must be addressed: While the government can create proactive e-services, are citizens ready for this transition? Many citizen initiatives focus on privacy and data protection.

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Public administration should align its goals with the public will. Developing legislation to facilitate the creation of proactive e-services is crucial for enabling innovation while minimizing adverse effects on citizen data privacy.

Developing a predictive business model entails inherent challenges. Designing one tailored for use with vast datasets and deployable within a Big Data framework is vital for proactive citizen services and introduces an even greater level of complexity. It is not just about fixing or empowering technicians; significant investment in IT infrastructure is needed to complete these tasks. A new way to solve day-to-day problems must be accepted and promoted within the organization.

Indeed, ethical risks are associated with predictive business models, particularly concerning potential discrimination due to inaccuracies or biases in data profiling. New developments must align with political concerns and advancements in citizens' daily lives, ensuring that proactive measures mitigate any adverse effects on individuals or communities. Ethical considerations should be paramount in the design and implementation of such models to uphold fairness, transparency, and social responsibility.

Economic requirements are needed in the legislative approval process. Showing the total expenses required to approve official rules and providing information about the total number of members exposed or affected by new legislation enhances the clarity of lawmakers' actions.

Incorporating economic requirements into the legislative approval process and delineating the total expenses required to implement official rules is paramount. Additionally, disclosing the total number of individuals exposed or affected by new legislation enhances the clarity of lawmakers' actions. This transparency not only bolsters accountability but also ensures that legislative decisions are informed by both financial considerations and their potential impact on constituents.

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