

Exploration of Alleviation Paths for Unbalanced Digital Services in Age-Friendly Cities from the Perspective of Algorithm Governance

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ABSTRACT

Due to the combined impact of urbanisation, an ageing population and digitalisation, many places around the world are now facing age-friendly smart city construction. However, with the rapid development of algorithm-driven digital public services, serious service disparities and an aggravated digital divide for older people have inadvertently occurred. This paper proposes a way to address the problem of uneven development of digital services in age-friendly communities through algorithm governance. Systematically analyze the structural, technical and cognitive dimensions of digital exclusion, and demonstrate how 'AI ageism' and algorithmic bias in resource allocation systematically disadvantage older adults. Incorporate the World Health Organization's age-friendly framework and contemporary theories of algorithmic accountability to identify three main forms of service imbalance in this study: infrastructural mismatch, algorithmic opacity, and participatory deficit. Therefore, the following multi-level governance path has been proposed. Institutionalisation of age-inclusive algorithmic auditing, enhancement of digital literacy through participatory design, and enforcement of transparent, explainable AI policies tailored to elderly cognitive patterns are included. In short, this paper offers some ideas for promoting equitable and inclusive ageing in old age in the new era of urbanisation.

KEYWORDS

Age-Friendly Cities; Algorithm Governance; Digital Divide; AI Ageism; Public Services; Digital Inclusion.

1. INTRODUCTION

The two large-scale global megatrends in the 21st century are rapid urbanisation and ageing populations. In light of the above changes in demographics, the concept of the 'age-friendly city' has been formally introduced to promote the development of urban areas that prioritise the health, safety and participation of older people. At the same time, the development of 'smart city' construction has also aimed to improve the efficiency of urban life by applying more digital technologies and data-driven infrastructure. Ideally, the two conceptual systems should be in harmony and use smart technology to promote age-friendly public services. However, the actual situation of urban digital transformation has repeatedly shown a severe problem: the technology that aims to improve life for older people has, in fact, exacerbated their sense of alienation within society.

At the foundation of this modern urban infrastructure is a large-scale network of algorithms and autonomous computational systems for resource allocation, public transport route planning, civic information filtering, and access control to essential healthcare and administrative services. Although the above algorithms have increased the efficiency of bureaucracy, they have also incorporated the values, assumptions and biases of their developers. With the rapid digitalisation of public services,

older adults have been left out in the digital age. Older adults often face difficult-to-understand digital interfaces, automated customer service systems without human empathy, and algorithmic service platforms that implicitly require a high level of technological literacy.

It is not that there are no devices; rather, it is a serious structural flaw in the provision of digital public services. When required for civic services, such as organizing health check-ups and distributing social welfare, and operating municipal transport systems, only algorithms are used; therefore, older adults without digital skills cannot exercise their basic civic rights. Therefore, the digital service gap may fail to achieve the goal of an age-friendly city and may instead create a space of technological isolation for older people.

This system of marginalisation is not only an unfortunate consequence of rapid changes in technology but also a serious defect in the general administration of municipal innovation. City administrators who apply the proprietary algorithm system of a private technology company blindly for public service optimisation may be in breach of their basic duty to guarantee equal access for all citizens. Generally speaking, the deployed algorithms aim to optimise indicators such as cost reduction, processing speed and reduction of user friction; these indicators are inherently unfavourable for users who need more time, special assistance or non-standard cognitive processing paths. Therefore, the bureaucratic friction that once spread throughout the civic system is now borne by older people to a certain extent. An older person using a complex municipal health portal or an automated transit booking system is not facing a 'usability problem'; they are encountering an algorithmic wall that is systematically denying them the public services funded by their taxes over the years.

Given the problem above, we need to change our way of thinking throughout the system. The traditional way of addressing the digital divide has been to help older adults learn how to use smart devices or some basic digital skills. Although necessary, these interventions are not sufficient because they fail to address the root causes in the architecture of the digital system. We need to shift the focus from "how to improve the user" to "how to regulate the algorithm". Algorithm governance will ensure the transparency and accountability of design in this endeavour to address the existing service asymmetry.

This paper studies all-encompassing mitigation paths for the imbalance in digital services in age-friendly communities through the lens of algorithm governance. Based on the above introduction, Section 2 will explore the features and theory of "AI ageism" and the new digital divide. Section 3 investigates the particular algorithmic reasons for service differences in smart cities. Section 4 puts forward feasible, multi-dimensional governance paths to reduce the disparity. Finally, Section 5 presents the main content of this paper and offers some thoughts on the future development of inclusive urban digital policy.

2. THE EVOLUTION OF THE DIGITAL DIVIDE AND AI AGEISM

In order to regulate the algorithms that build the urban service system effectively, we must first understand the form of digital exclusion among older people. The World Health Organization's first guide for age-friendly cities in the world pointed out that communication and information should be accessible, understandable and fair in distribution [1]. However, the following digitalisation of the information paths largely disregarded this requirement. Early studies on the digital divide focused mainly on the concept of hardware access, dividing people into "haves" and "have-nots". Now, in a smart city, simply having a smartphone or high-speed internet access is no longer sufficient; people need to be able to use these tools effectively and understand how algorithms work [10].

This multi-dimensional exclusion is closely related to the new theoretical idea of 'AI ageism'. AI ageism refers to the institutional practices, ideology and design choices in the field of artificial intelligence that intentionally or unintentionally discriminate against older people [4]. Ageism at these levels is also present in the digital public services. Many algorithms have been trained on large

amounts of data at the technical level that show severe age-related representation bias. Due to the lack of historical digital data for older adults compared with younger generations, machine learning models have struggled to learn specific behaviour patterns and service needs for older adults accurately [6].

AI ageism also manifests subtly in the language and Design of systems. Most of the digital public services have been developed by young software engineers who, in their own minds, have prioritised speed, a small number of interfaces and quick multi-tasking; these features are often in direct conflict with the cognitive and physical conditions of older people. Therefore, older adults who use these algorithmic systems are more likely to feel anxious, experience cognitive overload and suffer from a sense of being excluded by the system. Dynamism is expected to reduce people's access to necessary urban services and, at its base, to diminish their sense of civic dignity and self-determination; thus, it fails to meet the inclusive spirit of the age-friendly city framework [5].

The effects of this multiple layers of ageism are very damaging to the mental health of older adults. When older people repeatedly fail to use the essential online public services correctly, they often believe that it is due to their own cognitive decline. This internalised frustration results in a phenomenon known as 'technological resignation', and older people proactively stop trying to use the digital civic facilities and thus voluntarily cut themselves off from essential urban services. This resignation will result in a negative feedback loop for the algorithm developers. As older people no longer use the platforms, their particular interaction data will be excluded from the machine learning pipeline at the same time. Then the algorithm will focus on optimizing the interface and service delivery for the younger, more active group of users and permanently exclude older people from the structure of the smart city.

3. ALGORITHMIC MECHANISMS DRIVING SERVICE IMBALANCES

The translation of AI ageism into actual service disparities in the smart city takes place through several specific algorithms. The first is the algorithmic opacity of the automated public administration system. When the municipal digital government platform is used to access social welfare, housing and mobility services, older adults may have difficulty understanding the rules, data assumptions and procedures for the digital service [8]. When an older person is denied by an algorithm, they do not know the reasons for this decision and are therefore unable to appeal. Algorithmic opacity violates older persons' right to a fair trial and administrative review.

The second cause of service disparity is the optimisation logic in the urban algorithm. Algorithms are designed to maximise the overall efficiency of a system, and thus, the statistical majority is often favoured over the needs of a vulnerable minority. For example, the route-optimisation algorithm in a smart mobility system may choose a high-traffic commuting route to reduce the overall congestion in the city. Therefore, if the smart mobility system focuses on high-volume commuting areas, peripheral roads and other types of transport for older adults may be overlooked in data-driven planning [2]. This logic of ruthless efficiency has reduced resources for older adults systematically and created a serious spatial and temporal service gap in the city.

Optimisation of algorithms will likely result in a single mode for public services, and thus fail to address the large-scale differences among older people. Older people are not all the same; they have different degrees of physical fitness and memory, varying abilities in language, different social backgrounds, etc. Most allocation algorithms have the same general demographic profile. If the algorithm in a smart city allocates at-home care resources based solely on standardised predictive risk models, it will inevitably fail to meet the specific needs of older adults who do not fit the model's pre-set parameters. The algorithm lacks the required administrative discretion and emotional flexibility to handle the various circumstances of elderly care differently for each person.

A third, growingly serious mechanism is the phenomenon of algorithm-induced digital addiction and cognitive control. Although most of the previous studies have focused on digital exclusion, recently a dual pattern has appeared: older adults who have crossed the digital divide are now also vulnerable to algorithmic exploitation [11]. Algorithms for social media and digital content platforms are designed to maximize user engagement. Older adults living alone or experiencing loneliness may develop an excessive dependence on digital devices as a result of these addictive design patterns, and are therefore more vulnerable to algorithmic misinformation, health scams and other types of digital financial fraud [9]. Thus, the disparity in digital services is not only a lack of access but also a highly predatory algorithmic environment that has not been adequately regulated for vulnerable older adults.

4. MULTI-DIMENSIONAL GOVERNANCE PATHWAYS FOR ALLEVIATION

Given the above severe service deficiencies, all levels of the algorithm will be subject to supervision. The first is the institutionalisation of age-inclusive algorithmic auditing. Municipal governments need to build age-sensitive algorithmic review mechanisms for public service systems that may affect older adults' access to welfare, mobility, health care and administrative services through automated decisions [6, 12]. These audits need to examine the representation diversity of the training data and quantitatively verify that the results of the algorithm do not harm older people disproportionately. If a smart city technology fails to show age-equitable results, then it should not be applied in the public sector or must be severely restricted.

The second way is to change the basic design process of civic algorithms through participatory governance. In the past, older people have been entirely excluded from the places where technological power and policy are discussed [7]. To address the lack of participation by the public, the city will introduce co-creation. Older adults should be actively involved in the development cycle of digital public services and, rather than being only end-users, can also influence the goals of algorithms and accessibility of interfaces, as well as priorities for service improvements [3]. By integrating the actual life experience of older adults into the technological system, algorithms can be optimised for people-centred care and convenience, rather than just cold, efficient operation.

In light of the above shortcomings, the algorithm-governed entity will also establish convenient and easy-to-access digital complaint windows. Currently, when an older person is algorithmically denied access to a municipal service, such as a special transit pass or housing subsidy, even the appeal process itself is fully digitised and automated, resulting in a Kafkaesque nightmare of recursive algorithmic exclusion. A true age-friendly governance model should automatically trigger a prompt notification of a human-led review upon any automated denial-of-service. The members of the review panel should be public servants with specific training in identifying algorithmic bias and an understanding of the special circumstances of older adults. Establish clear legal responsibility for the decisions made by algorithms, provide older adults with an easy-to-understand, analogue channel to appeal these decisions, and thus quickly restore public trust in smart cities and address the most serious problems of the digital divide.

Finally, the algorithm governance mechanism will strictly require explainable artificial intelligence (XAI) and a human-in-the-loop fallback mode. Explainable AI needs to offer clear, easy-to-understand reasons for the automated decisions made by public service algorithms, and these should suit the cognitive processing needs of older adults. Also, the demand for full digitalisation should be moderated. True digital inclusion for an age-friendly city should preserve high-quality analogue options. Municipalities need to ensure that older adults can always choose to avoid the algorithmic interface and contact a well-trained, empathetic human civil servant without penalty or a reduction in service quality. This combination will not reduce the basic dignity of the people through digitisation.

5. CONCLUSION

Research on the path to alleviating the imbalance of digital services through the lens of algorithm governance offers new prospects for current urban policies. As the world's cities are advancing in smart technology, there is a risk that the basic ideas of an age-friendly city may be overlooked. Unsupervised applications of algorithms in public service delivery have begun to drive new forms of systemic inequality by exacerbating the digital divide through AI ageism, opaque automated decision-making, and ruthless optimisation models that marginalise older adults.

To avoid creating a city of smart technology for a select few, local governments, tech companies and civil society must proactively build good governance for algorithms. We should change our way of thinking and start to treat older people in a more favourable light as important members of the digital society. Strengthen the construction of all-age inclusive algorithms, mandate participation in co-design processes, and guarantee the full availability of transparent, human-assisted service channels to actively break down the structural barriers of digital exclusion.

In the end, the actual achievement of a smart city will not be reflected in high-speed digital networks or good algorithms. It should be evaluated according to its morality and structure, and it needs to protect, serve and empower the most vulnerable groups in society. By strictly regulating the algorithms that are increasingly shaping urban life, society can create a future where technological progress and ageing in society are not in opposition but rather in harmony, forming an all-encompassing, resilient and deeply age-friendly urban environment.

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