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Big Data and the Welfare State: A Promising Alliance for the Future

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Abstract: The welfare state is based on the principle of solidarity, whereby all citizens contribute to financing social insurance programs that protect them against social risks such as illness, old age, and unemployment. However, social systems are often characterized by information asymmetry, which can undermine their effectiveness and efficiency.

In the era of Big Data, social sciences and data sciences can combine to provide new solutions to this problem. Big Data enables the collection and analysis of large volumes of data, which can help reduce information asymmetry and improve decision-making in social systems.

The Moroccan social register information system is a key element in the government's strategy for implementing the welfare state. It collects data on Moroccan households' living conditions, which is then used to generate social indicators and monitor the impact of public policies.

The objective of this article is to explore the potential of Big Data to improve the effectiveness and efficiency of social systems. It proposes an approach that combines social science and data science methodologies to measure the outcomes and impact of these systems on poor and vulnerable populations.

Keywords: *Welfare State, Big Data, Social Sciences, Data Sciences.*

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I. INTRODUCTION

Information has become an essential resource in the modern era, and its role in shaping social policies is increasingly crucial. As an innovative technology, Big Data provides an unprecedented source of information to inform policy decisions and enhance the effectiveness of social interventions.

Governments worldwide collect and store massive amounts of data. Determining appropriate policies to regulate access and usage of this data while ensuring privacy and confidentiality protection is a major challenge.

The emergence of new sampling techniques and dynamic software platforms has revolutionized data analysis. Scientists can now leverage scientific, medical, and environmental information from various private and public sources to address national and global challenges.

New knowledge and insights derived from Big Data can offer solutions and illuminate important research pathways across multiple fields. For instance, data analysis

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can enhance public health by identifying links between demographic characteristics and disease incidence. Similarly, climate change and biodiversity data can help predict disruptions in agricultural markets, enabling governments to engage in long-term planning (Okediji, 2016).

The social protection sector lags behind the private sector in adopting digital technologies. However, this gap can be bridged by investing in the necessary infrastructure and skills to harness the full potential of Big Data.

Big Data has the potential to revolutionize the development of social policies by providing a better understanding of population needs and enabling more targeted and effective interventions. By addressing the challenges of Big Data governance and investing in technology and expertise, governments can leverage this potential to create fairer and more inclusive societies (Gillingham, 2019).

In this context, the Moroccan social register information system is a fundamental pillar of the government's strategy to establish a strong welfare state. Its primary role is to collect detailed information on the living conditions of Moroccan households. Once compiled, this data is used to create social indicators, allowing the evaluation of public policy effectiveness and the identification of areas requiring government intervention. Furthermore, this system provides a comprehensive overview of the population's socio-economic needs, helping the government design targeted initiatives and allocate resources efficiently to enhance citizen well-being.

II. THE WELFARE STATE IN THE ERA OF BIG DATA: OPPORTUNITIES AND CHALLENGES

The welfare state assumes the fundamental responsibility of ensuring social protection for all citizens. At the same time, Big Data, which is essential for managing and analyzing massive amounts of data beyond traditional capabilities, is revolutionizing numerous sectors, including public services.

A. The Concept of the Welfare State

The welfare state is a benevolent democratic institution whose primary responsibility is to ensure social protection for all its citizens, regardless of age, gender, socio-economic status, or family background. It categorically rejects the trickle-down theory and establishes the state as the guarantor of distributive justice in society (Vivekanandan, 2022, p. 5).

A common definition found in textbooks states that the state is responsible for ensuring a minimum level of well-being for its citizens. However, such a definition overlooks many critical questions, such as whether social policies are empowering or not, whether they contribute to system legitimacy, whether they serve social justice, and whether they legitimize or contradict the market process. Moreover, it does not clearly define what is meant by "basic needs." Should we not demand that a welfare state provide more than just minimal well-being? (Esping-Andersen, 1990, p. 18).

Esping-Andersen's welfare state system places great importance on distributive justice. Beyond providing authorized social services, it also adopts ideological positions regarding the roles of the family and society as providers and recipients of social services. It establishes institutional frameworks at different levels to ensure that all inhabitants of a country have decent living conditions, receive the necessary social services, and that funds are allocated to these institutions to cover expenses.

The state's responsibility for social protection is a key element. In doing so, it also plays a distributive and redistributive role to promote equality in living conditions within society. It is important to note that, in a welfare state, ensuring a decent standard of living is a recognized social right (Vivekanandan, 2022, p. 5).

A welfare state is one that commits to providing basic economic security for its citizens by protecting them from market risks associated with old age, unemployment, and illness. This protection is ensured through a series of social policies, including healthcare, unemployment benefits, and retirement pensions. As protection standards evolve and new risks emerge, policies must be adjusted accordingly.

B. The Concept of Big Data

Big Data is a concept that emerged from the need to manage and analyze massive volumes of data that exceed the storage and processing capabilities of traditional computers. This evolution led to the development of new technologies such as MapReduce and Hadoop, which allow for large-scale data processing without requiring prior structuring. Today, Big Data encompasses activities that cannot be carried out on a small scale, aiming to extract new insights or create value. Its impact is significant on markets, organizations, relationships between citizens and governments, and many other aspects of society (Victor & Cukiere, 2013).

Big Data is often poorly defined, leading to confusion and uncertainty. A common definition describes it as data of high volume, high velocity, and high variety, requiring innovative management and processing methods to enhance understanding and decision-making. The focus is placed on the "3 Vs": volume, velocity, and variety. However, some add other "Vs," such as value or variability, to fully exploit the richness of data (Loshin, 2013).

Big Data is characterized by its immense volume, rapid or even real-time generation, and its inability to be analyzed by a single user. This data is continuously collected in a non-reactive manner and is not specifically intended for evaluation. Evaluators often have to use proxy variables for their analyses. The advantages of Big Data for evaluation research include the ability to obtain data on the entire population, reduced costs of accessing vulnerable groups, integration of different types of data into a common database, and increased availability of longitudinal data.

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This opens up new possibilities for evaluating programs in complex contexts and tracking processes and behavioral changes (York & Bamberger, 2019.

Table 1: Comparison between Big Data and Traditional Data

Feature	Big Data	Traditional Systems
Data Type	Structured, Semi-structured, Unstructured	Primarily Structured
Data Volume	Very large (Terabytes, Petabytes)	Smaller (Gigabytes)
Data Speed	High-speed (real-time or near real-time)	Slower (batch processing)
Data Variety	Various sources (logs, social media, sensor data)	Limited sources (transactions, customer data)
Architecture	Distributed processing	Centralized processing
Analysis	Exploratory analysis to discover hidden insights	Answers predefined questions
Scalability	Highly scalable to accommodate growing data volumes	Limited scalability
Cost	Higher initial infrastructure costs	Lower initial costs
Advantages	Discovering deeper insights, improving decision-making, identifying trends	Efficient data storage and retrieval, report generation

Source: Rajendran et al., (2016)

C. Leveraging Big Data to Transform Public Services

Data, particularly that derived from Big Data, is essential in various fields such as the economy, social services, and security. It enhances economic efficiency, facilitates access to social services, strengthens security, enables service personalization, and increases the availability of relevant information. Big Data also optimizes organizational operations, fosters innovation and adaptability, and improves resource allocation. Technological advances in data analysis reduce the time required to process large volumes of data.

In the healthcare sector, Big Data presents opportunities to enhance human well-being by designing optimal therapies and more effectively regulating medications. Additionally, massive datasets can be used to prevent the spread of communicable diseases. A notable example is the analysis of the 2010 cholera outbreak in Haiti, where the use of Twitter data and online news articles could have enabled earlier disease detection (Kshetri, 2014).

- *Better Anticipation of Citizens' Needs and Expectations*

Big Data has significant potential to improve citizens' health and social security in the future. It offers the possibility of addressing complex and crucial social issues related to healthcare, social security, and well-being, such as the prevention and management of communicable diseases, person-centered collaborative care, and responses to challenges related to terrorism, disasters, and global risks. For instance, monitoring individual lifestyles and sensory data can help prevent chronic diseases, while analyzing data from multiple sources can detect early signals of social issues and the need for social services. Moreover, by tracking and analyzing social media data, effective policies can be developed (Song & Ryu, 2015).

- *Optimization of Resources and Decision-Making Processes*

Social security policy is crucial for citizens' economic stability but faces major challenges in data management. The use of Big Data offers promising prospects by centralizing data management and processing through cloud storage, thereby reducing costs and improving the efficiency of social security programs. This transition enables better utilization of data to inform policymakers, allowing for a proactive approach to social needs and the adaptation of social security programs. By harnessing the potential of Big Data, not only can current challenges in social security data management be addressed, but the quality and efficiency of social policies can also be significantly enhanced in the future (Zhou & Ye, 2019).

- *Strengthening Transparency and Accountability*

The application of Big Data aims to enhance efficiency by promoting greater internal transparency. This enables both citizens and governments to make better decisions and optimize internal processes. Additionally, the use of personal data allows for the personalization of public services and continuous improvement based on performance indicator analysis, thereby addressing citizens' specific needs and improving service quality. These advancements also foster innovation by facilitating the reuse of data to develop new services and provide solutions tailored to societal needs (Cavanillas et al., 2016).

D. Challenges Related To Big Data Utilization

The ethics of Big Data raise concerns about data privacy, while data quality and security pose major challenges requiring detection and remediation solutions. Interoperability between datasets is crucial for reliable and efficient processing systems.

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➢ *Protection of Personal Data*

The use of Big Data raises significant ethical concerns, particularly in healthcare and social assistance. Debates revolve around individuals' consent to the use of their personal data and privacy protection. While consent is ideally sought, its collection can be complex and costly. Moreover, ensuring informed consent is challenging since the goals and methods of Big Data are not always clearly defined at the time of data collection. The distribution of data to third parties for analysis also raises ethical concerns, particularly regarding adherence to professional codes, privacy protection, and data anonymization (Gillingham, 2019).

➢ *Data Quality and Security*

Data quality is essential for the effective use of Big Data. Poor-quality data leads to inefficient use of transmission and storage resources, as well as usability issues. Several factors influence data quality, including generation, acquisition, and transmission, which are reflected in criteria such as accuracy, completeness, redundancy, and consistency. However, despite efforts to improve data quality, persistent issues necessitate the development of automatic detection and repair methods for damaged data.

Big Data also presents security challenges, particularly regarding encryption, due to its vast size and diversity. Traditional encryption methods are inadequate for such large datasets, making it necessary to develop encryption techniques specifically tailored to this scale. Security management, access control, and secure communications must also be further developed to ensure data protection (Chen et al., 2014).

➢ *Interoperability*

Designing systems to collect, process, and analyze large volumes of data for reliable decision-making is complex and costly. However, widespread adoption depends on the interoperability of datasets and approaches across different data sources. Innovation and interoperability in large-scale data processing systems are essential for ensuring effective and reliable decision-making (Zillner et al., 2021, p. 44).

III. EXAMPLES OF BIG DATA APPLICATIONS IN SOCIAL ASSISTANCE

The following examples illustrate how Big Data can be a powerful tool for improving the delivery of social services and more effectively addressing the needs of vulnerable populations.

A. The Human Resources Administration (HRA) of New York

The HRA is an agency dedicated to combating poverty and income inequality, assisting over 3 million New Yorkers with food aid and emergency rental assistance. The preliminary budget for the 2024 fiscal year for HRA is $10.7 billion, representing 10.4% of the city's total budget of $102.7 billion (Ayala, 2024, p. 2).

The Self-Sufficiency Employment and Assessment Management System (SEAMS) was implemented by HRA to manage employability, replacing the NYCWAY system in June 2023. SEAMS leverages Big Data analytics to detect fraud and enhance the efficiency of HRA's social assistance programs. Its objectives include improving employment services, increasing participants' self-sufficiency, and reducing dependence on public assistance.

While SEAMS offers advantages such as a comprehensive overview of cases, more efficient data management, and enhanced user-friendliness, it also faces challenges, including its complexity, ongoing development, and the risk of leaving some participants behind. Despite these challenges, SEAMS is regarded as a promising system for improving HRA's employment services. However, addressing its obstacles is crucial to ensuring its success (HRA Policy Bulletin, 2023).

B. The Aadhaar System in India

Aadhaar is a 12-digit unique identification number issued by the Unique Identification Authority of India (UIDAI). It is used in various social assistance programs in India to enhance beneficiary targeting, reduce corruption, and ensure transparency. However, concerns have been raised regarding the exclusion of eligible beneficiaries, privacy protection, and the digital divide.

The debate on Aadhaar's role in social programs is complex, with valid arguments on both sides. It is crucial to carefully assess the potential benefits and drawbacks of linking Aadhaar to social welfare programs, ensuring an inclusive, transparent, and privacy-respecting implementation. Additionally, safeguards must be established to mitigate the risks of exclusion and data misuse, ensuring a fair and responsible application of this technology (Khera, 2017).

C. The French Family Allowance Funds (CAF)

In France, the Family Branch, also known as Allocations Familiales, provides families with various forms of assistance, such as income supplements, equipment support, guidance, and counseling. These benefits are distributed through a network of 101 CAFs (Family Allowance Funds), overseen by the Caisse Nationale des Allocations Familiales (CNAF). In 2022, this branch covered 32.4 million people and assisted 13.5 million beneficiaries, with a total of €99 billion in benefits disbursed (www.caf.fr).

In 2016, the CAF identified nearly 43,000 cases of fraud, marking an 8% increase compared to the previous year, with a total fraud amount of €275 million. The CNAF attributed this rise not to an increase in fraud itself but to enhanced efficiency in control mechanisms. This improvement, along with previous years' results, was largely due to the deployment of data mining, a Big Data-based method. Similar to tax administrations, social protection organizations are increasingly adopting the these advanced data analysis techniques to detect fraud more effectively (Chevallier & Tauber, 2018, p. 2).

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IV. THE UNIFIED SOCIAL REGISTRY INFORMATION SYSTEM IN MOROCCO

The Unified Social Registry (RSU) is a centralized system established by the Moroccan government to accurately identify households eligible for social assistance programs. By consolidating socio-economic data, the RSU aims to enhance the targeting and delivery of social support, ensuring that benefits reach those who need them most (World Bank, 2024)

A. The Unified Social Registry (RSU)

Unified Social Registry (RSU) is a national information system designed to register families seeking access to social assistance programs. It identifies beneficiaries using a socioeconomic indicator reflecting their standard of living. Registration is open and free for Moroccan citizens and foreign residents in Morocco.

➢ RSU's Objectives Include:

- Digital management of household socioeconomic data, including collection, registration, archiving, and updating as needed.
- Assigning a socioeconomic score to families based on their social and economic conditions.
- Creating ranked lists of families according to their socioeconomic index, providing necessary information to determine eligibility for social support programs based on specific thresholds (RSU, n.d.).

B. The National Population Register (RNP)

National Population Register (RNP) is a digital platform that registers all residents in Morocco, whether citizens or foreign residents. Each registrant receives a Civil and Social Digital Identifier (IDCS). This register provides an authentication service for social programs by cross-referencing declared registration data with information recorded in RNP.

Personal data is accessible only to authorized partners accredited by National Registry Agency (ANR). This simplifies procedures for accessing social programs while ensuring data confidentiality and security. RNP's creation is part of social support system reform in Morocco, which aims to modernize beneficiary identification and targeting within social assistance programs (RNP, n.d.).

C. The Social Score Calculation Formula

The social score calculation formula is a numerical socioeconomic indicator assigned to families registered in the RSU. It was developed by the High Commission for Planning (HCP) with technical support from the World Bank. This system helps define specific thresholds for each social program, determining family eligibility based on their socioeconomic index.

Table 2: Social Score Calculation Formula

Urban Areas	Rural Areas
Smu = ∑_(i=1)^(i=35) Ci × Vi + Kzg + Kmu	Smr = ∑_(i=1)^(i=28) Ci × Vi + Kzg + Kmr

- Kmu = 9.825 (urban constant)
- Kmr = 8.695 (rural constant)
- Kzg: Regional constant (e.g., Oriental Region: Kzg = 0.196)
- Kmr: Regional constant (e.g., Oriental Region: Kmr = 0.230)
- Ci: Weighting coefficient
- Vi: Socioeconomic variable value

Source: High Commission for Planning & World Bank, 2020.

The social score calculation formula classifies households based on their socioeconomic conditions. To qualify for direct social assistance, a family must have a score below 9.743001 (High Commission for Planning & World Bank, 2020).

However, urban residents face challenges, as the urban constant (Kmu = 9.825) alone exceeds the eligibility threshold, even before considering the regional constant (Kzg). Moreover, certain household assets—such as a bathroom, electricity meter, TV receiver, computer, or telephone—can increase the score, excluding most urban families from eligibility (Arab Reform Initiative, 2024).

Due to strict eligibility criteria, some families may artificially increase household size to lower their social index and qualify for direct financial aid. However, this leads to a new dilemma: large families struggle to fairly distribute the fixed 500 MAD in social aid among their members (Morocco World News, 2024).

Adding to the complexity, the government introduced regulations requiring unemployed but capable individuals to contribute to the National Social Security Fund (CNSS), even if they do not generate any income (PwC, 2024).

- Any person not meeting the threshold for the basic compulsory health insurance scheme is considered capable of contributing to the basic health insurance scheme, even if they cannot afford membership fees.
- Contribution amounts are based on scores assigned under the social program beneficiary targeting system.

A critical issue arises: some direct social aid beneficiaries (scores between 9.743001 and 9.3264284) are classified as mandatory CNSS contributors.

Thus, individuals receiving the 500 MAD social aid—except those under "AMU Solidarité"—must pay either 144 MAD or 176 MAD to CNSS to access healthcare services. This reduces final net assistance to only 356 MAD, further

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limiting the program's effectiveness for vulnerable households.

V. CONCLUSION

This study highlights the growing importance of Big Data in enhancing social systems, emphasizing its ability to reduce information disparities and improve the efficiency of social programs.

Furthermore, Big Data enables a more proactive approach to delivering social services. By analyzing data in real time, decision-makers can anticipate emerging trends, forecast future needs, and swiftly adjust their strategies accordingly. This ability to make informed, data-driven decisions in real time is essential for responding agilely to complex social challenges.

However, the use of Big Data by governments also raises concerns regarding privacy protection and data security. It is crucial to establish robust legal and regulatory frameworks to ensure that citizens' data is used ethically and securely while safeguarding their fundamental rights.

Various government initiatives worldwide illustrate how Big Data is being leveraged to optimize public services, improve resource management, and address complex social challenges such as public health, education, and crime prevention.

The central role of the Moroccan Social Registry in the government's strategy to strengthen the social state is undeniable. By combining detailed household data with advancements in social sciences and data sciences, this registry provides relevant social indicators and enables effective monitoring of public policies. This approach facilitates more precise interventions and a deeper evaluation of the impact of these policies on vulnerable groups.

The formula for calculating the social score, developed by the High Commission for Planning with the support of the World Bank, classifies households based on their socio-economic conditions. However, certain complexities—such as the eligibility threshold, the requirement for some social aid beneficiaries to contribute to the National Social Security Fund (CNSS), and the contribution amounts imposed based on the scoring level—pose challenges for families and highlight the intricacies of the social assistance system in Morocco.

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