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Research Article

Promoting data element circulation for urban digital economy development

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Abstract

Data element circulation, also known as data circulation, refers to the entire process of continuously collecting, processing, storing, transmitting, and using data in economic and social activities. The rapid development of information technology has made the data elements circulation an important driving force for promoting economic growth, improving production efficiency, and fostering social innovation. However, the data elements circulation also presents a series of challenges, including data value, data security, data quality, data openness, and sharing. To fully unleash the value of data resources, improve the new foundational system, stimulate market vitality, and create a data element market with significant influence, this paper conducts a thematic study on promoting data element circulation. The significance of accelerating data element circulation, the global efforts in data element circulation, and the basic requirements for data element circulation are discussed. The paper also provides recommendations for promoting data element circulation, including policy and regulatory development, infrastructure enhancement, and continuous technological innovation. Furthermore, the paper emphasizes the importance of strengthening application scenarios, such as smart city initiatives and data center services and building a robust support system for data element circulation. The proposed strategies aim to foster high-quality development of the urban digital economy and facilitate the circulation of data elements.

Abbreviations

US: United States; EU: European Union; GDPR: General Data Protection Regulation

Introduction

The current development of the digital economy is unprecedented in terms of its rapid pace, wide range of radiation, and profound impact. It is emerging as a crucial force for realigning global resources, reshaping the global economic structure, and transforming the global competitive landscape. The development of the digital economy has gained widespread international recognition [1,2]. The impact of the digital economy on the socioeconomic fabric of cities can be analyzed in the following aspects.

1. **Promoting innovation and entrepreneurship:** The digital economy provides more opportunities and platforms for innovation and entrepreneurship. Innovators can conduct business more conveniently through Internet and mobile communication technologies, and improve the quality of products and services through technologies such as big data analysis and artificial intelligence. This innovation and entrepreneurship activity will promote the transformation and upgrading of the urban economic structure.

2. **Optimizing industrial structure:** The development of the digital economy puts traditional industries under pressure to transform and upgrade. On the one hand, the digital economy promotes the digitization transformation of traditional industries, improving

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their efficiency and competitiveness. On the other hand, the digital economy also gives birth to emerging industries such as e-commerce, sharing economy, and Internet finance, which become new growth points in the urban economic structure.

3. **Reshaping employment patterns:** The development of the digital economy has a significant impact on employment patterns. The demand for traditional labor decreases while the demand for digital and information technology talents increases. The digital economy provides more flexible employment opportunities, such as freelancing and remote work. This change in employment patterns also has a profound impact on the social and economic structure of cities.

Consider Uber [3] as a case study. Uber is a mobile app-based ride-hailing platform that enables optimized vehicle scheduling and supply-demand matching by collecting and analyzing data on users' travel needs and behaviors. This flow of data elements not only drives the growth of Uber but also has an important impact on the urban digital economy. The emergence of Uber has changed the traditional way of travel, improved the efficiency of urban transportation and user experience, and then changed the urban traffic structure and travel habits. At the same time, Uber has created jobs for many cities, driven the growth of urban economies, and had a profound impact on urban transportation and economic structure.

The promotion of data element circulation can accelerate the establishment of a sound, orderly, open, collaborative, and well-governed environment for the digital economy [2].

Ensuring the high-quality supply of data and facilitating the smooth flow of factors in circulation and transactions is essential. Expediting the secure, reliable, and efficient circulation of data elements has become a focal point of attention and a competitive battleground [4]. The leader who acquires the key technology and fundamental institutional mechanisms will have a significant advantage in digital development [2,5,6].

Conducting data governance is of great significance for comprehensively improving government efficiency, and empowering public services and social governance. Facilitating the orderly and free flow of data elements among the government, market, and society is crucial for economic development, people-oriented services, and urban governance. It also offers convenient government services for businesses and other market entities, streamlines administrative procedures, and boosts operational efficiency to optimize the business environment [6-8].

In order to fully realize the value of data resources and stimulate the vitality of market players, this article conducts in-depth research on facilitating the circulation of data elements to support urban development and promote the high-quality advancement of the urban digital economy.

This paper makes several key contributions to the field of data element circulation:

1. **Conceptual framework:** This paper provides a conceptual framework for understanding and promoting the circulation of data elements. By providing a comprehensive framework, this paper offers valuable insights for policymakers, researchers, and practitioners in developing strategies and solutions to facilitate data element circulation.

2. **Solutions for institutional and technical challenges:** The paper proposes solutions to address the institutional and technical challenges in promoting the circulation of data elements. These solutions provide practical guidelines for stakeholders to make decisions and effectively promote data element circulation.

3. **Support and guarantee system:** This paper highlights the importance of building a robust support and guarantee system for data element circulation. It emphasizes the need to enhance the digital literacy of the general public, strengthen the capabilities of scientific research institutions, and support the implementation of data circulation applications in enterprises, which provide a roadmap for establishing a comprehensive support system.

The rest of the paper is organized as follows: In Section 2, we provide an overview of the current state of data element circulation and highlight its significance in the digital economy. Section 3 discusses the current state of data element circulation and identifies the conditions necessary for promoting data element circulation. Section 4 proposes solutions to accelerate the circulation of data elements, including advancing data governance technology systems, expanding application scenarios, and building a robust support and guarantee system. Finally, in Section 6, we summarize the key findings and propose recommendations for building a robust data element circulation support and guarantee system.

By addressing these aspects, this paper aims to provide valuable insights and guidelines for policymakers, researchers, and industry practitioners in developing a robust support system for data element circulation.

Related works on the global circulation of data elements

In the era of the digital economy, countries have recognized the strategic status of data and attach great importance to data elements. Accelerating the marketization of data elements has become a common goal [1-2,7]. The global circulation of data elements can be summarized as follows.

1. **Promoting multi-dimensional government data open sharing:** Government data open sharing can be understood from three dimensions. Firstly, public data that can be opened needs to be unconditionally accessible to the whole society [8-11]. Secondly, shareable data should be shared between government departments

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and suitable enterprises. Lastly, confidential and non-disclosable data should be defined by a negative list as an exception for sharing and opening. Significant milestones in global data open legislation include the US "Open Government Data Act" and the EU "Open Data Directive" [12]. These legislations establish requirements for a unified government data open platform and mandate federal agencies to make their information available as open data in a standardized and machine-readable format online.

2. **Protecting the legitimate interests of data holders:** After the EU GDPR, personal data protection legislation has become a global trend [12-14]. Data sharing is generally based on voluntary sharing, and data access rights need to consider the legitimate interests of data holders and respect the legal framework. The GDPR grants individuals numerous rights regarding personal data protection. The "European Data Strategy" proposes providing users with tools and methods to better control and manage their personal data during the subsequent revision of GDPR and the development of the "Data Act" [14,15].

3. **Implementing graded and classified data rights:** Graded and classified data rights clarify the rights of creation, ownership, management, and re-use, as well as transaction rights of data [16-18]. They relate to data liquidity and effective use, defining the depth and breadth of open sharing and collaboration of data at different levels. Countries such as the United States, the European Union, China, and Japan have adopted laws, policies, and established regulatory institutions to establish and protect data rights in response to the diverse needs and challenges of graded and classified data [19].

4. **Negotiating the new pattern of geographical data interests:** With the development of the global digital economy, the geopolitical importance of data continues to emerge [20]. Countries emphasize data sovereignty for privacy protection, government enforcement, and industry development, demanding data localization. This poses a significant challenge to the free flow of data required by the globalized digital economy.

Foundation of circulation of data elements

At present, the development of data element circulation is generally in the initial stage, and the data market still needs to be cultivated. However, the growth rate is fast. It is transitioning from spontaneous development to an orderly regulation stage [5,6]. Further promoting the circulation of data elements requires the achievement of the following three conditions.

1. **Active policy and regulatory construction:** Data classification standards should be formulated, and data-sharing strategies should be developed according to data classification. Sharing should be the principle, and non-sharing should be the exception. Data security should be ensured as the bottom line, and the development and utilization of data should be coordinated. Each data processor should bear its respective security responsibilities for data that exists in multiple processors [2,6,8].

2. **Infrastructures:** Large-scale data storage centers, powerful supercomputing centers, and sound network facilities are necessary for data circulation [4].

3. **Continuous technical innovation:** Urgent technical breakthroughs are needed to address the three major dilemmas of data element marketization: the inability to conduct large-scale transactions with raw data, the incompatibility between the security and circulation of raw data, and the need to achieve "decoupling" between raw data and applications. Secure circulation is the bottom line, and improvements are needed in data ownership management, data rights confirmation, data pricing and evaluation, circulation incentives and accounting mechanisms, data quality control and inspection, and data supervision [21].

Overall, the main problems that still exist in the current circulation of data elements include the unclear definition of data ownership, high risk of data security, and imperfect data trading mechanisms [21,22].

Solutions to promote the circulation of data elements

To accelerate the circulation of data elements, it is urgent to explore and address issues related to the institutional system, technical system, and practical application. The solution is to accelerate the construction of a data element circulation system (Figure 1). This approach will lead to the high-quality development of the digital economy and promote the circulation of data elements.

Advancing data governance technology system: a leading pilot

To address the challenges posed by the high cost of construction, unclear data rights and responsibilities, and potential data security risks associated with the current physical centralization approach to data aggregation, it is essential to pioneer the use of data registration and data security technologies. This will enable the exploration and development of a technical architecture that promotes the accelerated circulation of data elements.

Building an overall technical framework for data element circulation: Through technical breakthroughs, an overall framework can be established. Data registration standards can be formulated to register data resources and transform them into data assets. These assets can be processed to generate data products and services, providing technical support for ubiquitous, cross-border, comprehensive, collaborative, efficient, and secure application scenarios.

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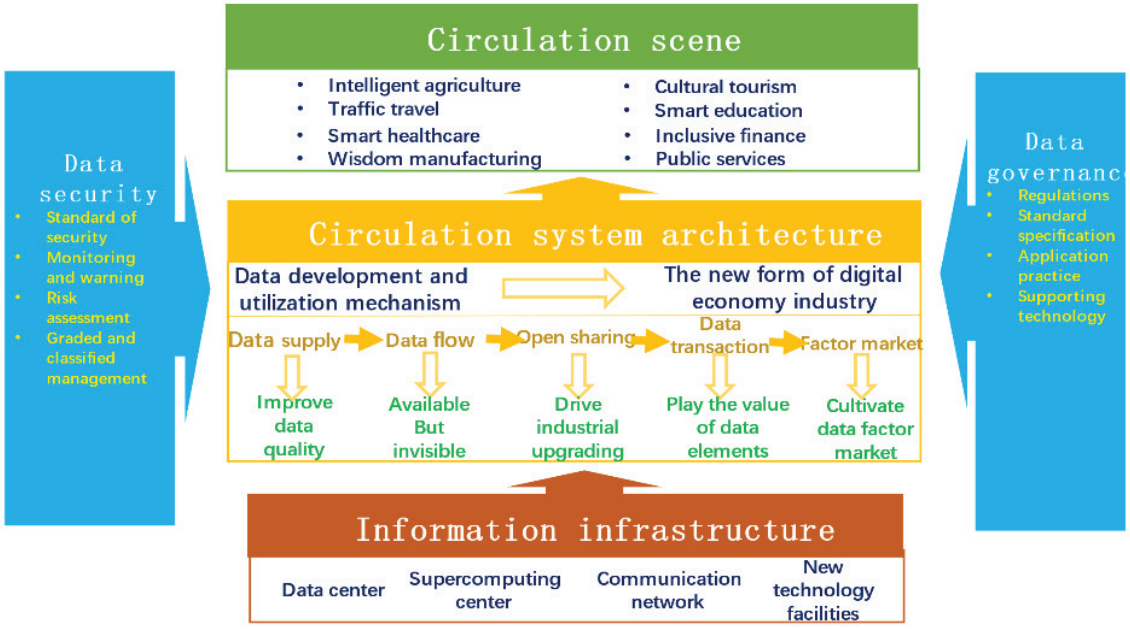

Figure 1: Data Element Circulation System.

Application of data security technology: By employing data security technology in conjunction with data registration technology, the challenges of data governance, including data ownership, data security, and data sharing, can be effectively addressed. This approach can significantly mitigate or resolve data security, data leakage and illegal data theft issues that arise during data circulation.

To activate value and create an ecosystem for data element circulation, it is essential to support the expansion of various fields in the thriving digital economy. This will broaden the scope of data element circulation and application scenarios. Focusing on smart city development, emergency response scenarios, public management, public services, and public safety applications is essential to facilitate data element circulation and realize the synchronized development of a business environment and industries.

Building a Robust data element circulation support and guarantee system

To provide strong guarantees and support for the development of the digital economy, it is necessary to improve the digital literacy of the general public, enhance the research strength of scientific research institutions, and support the implementation of data circulation applications in enterprises.

Comprehensively improving the digital literacy level and skills of the general public: To achieve this, it is crucial to continuously enhance the policy system aimed at enhancing the digital literacy of the general public. Additionally, the social training system should be perfected to ensure a more robust governance pattern and more powerful measures that benefit the people. By cultivating digital citizens with digital awareness, lifelong learning abilities, and social responsibility, the co-construction and shared development of digitalization achievements by the general public can be promoted.

Significantly Strengthening capabilities of scientific research institutions: To effectively support data element circulation, it is necessary to focus on core technologies and key mechanisms related to this field. This can be achieved through forging deep collaborations with scientific research institutions. By doing so, the research institutions can contribute their expertise and resources in advancing the development of data element circulation.

Vigorously support the landing and effective implementation of enterprise data circulation application scenarios: To facilitate the practical application of data circulation in enterprises, it is important to carry out pilot projects in urgent application areas. These projects should aim at exploring effective experiences and models that can be replicated. Financial institutions should also be encouraged to increase project financing services and broaden the sources of corporate investment projects. In order to achieve this, it is necessary to first accelerate the engineering application of data element circulation technology. Next, pilot demonstration projects for data element circulation application scenarios should be carried out. Lastly, implementable guidelines for data element circulation applications that can be promoted should be formulated.

By implementing these measures, a robust data element circulation support and guarantee system can be established, providing the necessary impetus for the development of the digital economy.

Future implications of data element circulation

The continued growth and advancement of data element circulation in the digital economy have significant implications for various aspects of society and the economy. In this section, we discuss the potential future implications of data element

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circulation, considering both the positive and negative aspects, as well as addressing potential challenges and roadblocks that may emerge.

Positive implications

Enhanced economic growth: The increased circulation of data elements can contribute to economic growth by enabling businesses to gain valuable insights, make data-driven decisions, and identify new opportunities for innovation and development.

Improved efficiency and productivity: Data element circulation allows for the efficient sharing and utilization of information, leading to enhanced productivity in various sectors. It enables the automation of processes, optimization of resource allocation, and streamlining of operations.

Facilitation of innovation: The availability of diverse and comprehensive data elements creates opportunities for innovation and the development of novel products, services, and business models. It fosters creativity and supports the emergence of new technologies and solutions.

Enhanced decision-making and policy formulation: Data element circulation provides policymakers, governments, and organizations with a wealth of information for evidence-based decision-making, policy formulation, and effective implementation of targeted strategies.

Negative implications

Data privacy and security risks: The increased circulation of data elements raises concerns about data privacy and security. The unauthorized access, use, or misuse of sensitive data can lead to privacy breaches, identity theft, and other cyber threats, necessitating robust data protection measures.

Data quality and reliability: As data elements circulate across various platforms, ensuring their quality, accuracy, and reliability becomes crucial. Inaccurate or unreliable data can lead to flawed analysis, incorrect conclusions, and misguided decision-making.

Future challenges and roadblocks

Legal and regulatory frameworks: The evolving nature of data element circulation calls for the development and implementation of appropriate legal and regulatory frameworks. Addressing issues related to data ownership, consent, protection, and cross-border data flows will be crucial for ensuring responsible and ethical data practices.

Data governance and standards: Establishing effective data governance mechanisms and standardized protocols for data element circulation will be essential. This includes addressing interoperability challenges, data sharing agreements, and establishing ethical guidelines for data usage.

Ethical considerations: The ethical implications of data element circulation, such as potential biases, discrimination, and unfair practices, need to be carefully addressed. Developing ethical frameworks and guidelines will help ensure that data circulation is conducted fairly and responsibly.

In conclusion, while data element circulation offers numerous benefits for the digital economy, it also poses challenges and risks. Addressing these concerns through appropriate regulations, governance mechanisms, and ethical considerations will be crucial for harnessing the full potential of data element circulation in the future.

Conclusion

In conclusion, promoting the circulation of data elements is crucial for the development of the digital economy and the establishment of a well-governed environment. The global community recognizes the importance of data and has taken various measures to facilitate the marketization of data elements. However, challenges related to data ownership, data security, and data trading mechanisms still need to be addressed. To overcome these challenges, it is recommended to prioritize the development of data governance technology systems, explore data registration and security technologies, and integrate data element circulation into various application scenarios.

Efforts should also be made to strengthen the support and guarantee system for data element circulation, enhance the digital literacy of the public, and support the implementation of data circulation applications in enterprises. By addressing these aspects, the circulation of data elements can be effectively promoted, contributing to the high-quality development of the digital economy and the realization of the full value of data resources. This will enable cities to leverage data for economic growth, improve public services, and enhance overall governance.

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