

the Path of Digitization and Marketization of Information Resources in the Perspective of Information Ecology

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Abstract

Information resources have become an important means of production in contemporary times, and the construction of information resources market is of great significance to improve the efficiency of information resources development and utilization, but its digitization and marketization process is still defective at this stage. With the help of information ecology theory, grasp the connotation of information resources, systematically analyze the main body, ontology and environment of the marketization process, combine the linkage between the digitization of information resources and the path of marketization, and construct the information ecological value chain, ecosystem and ecosystem of the information resources market. With the addition of digital technology, we summarize the information resource utilization and development paths that meet the dynamic transaction needs of the information resource market, promote the development of the information resource industry, and rectify the information resource market culture by using the regulation and system clearly.

Keywords

information resources, digitization, digitization, information ecology.

1. Introduction

Today, the rapid development of information technology, the amount of information has been exponential growth, and consequently the information resources, that is, one of the three major resources in the world today, along with energy and materials, has gradually attracted a high degree of attention from society. Information, as a product of reducing uncertainty, its role has long been played in a number of fields. April 9, 2020, the CPC Central Committee and the State Council issued the "opinions on building a more perfect institutional mechanism for the market-oriented allocation of factors", emphasizing the need to enhance the value of social data resources, cultivate new industries, new business forms and new modes of the digital economy, and support the construction of agriculture, industry, transportation, education, security, urban management, public resource transactions and other areas of standardized data development. management, public resource transactions and other areas of standardized data development and utilization scenarios [1]. With the continuous innovation and popularization of Internet technology, a large amount of information resources are digitally stored and disseminated, which provides convenience for people to obtain information. These scenarios involve numerous fields and point out the direction for the future reform of information resource marketization. It is expected that with the development process of marketization of information resources, China's economy will become more competitive and will be able to better release the digital dividend in the next development process.

In the era of information resources, information content is becoming more and more complex, for the purpose of maximizing the use of information resources, individual and enterprise decision-making has been changed from the traditional decision-making that relies mainly on part of the information already obtained, i.e., through the individual's wisdom, significant

experience and knowledge, to the more advantageous decision-making that requires the support of a certain amount of information resources and is supported by the most comprehensive information possible. At the same time, digital technology has also opened up new ways for the marketization of information resources, promoting the development and prosperity of the information industry. In this context, it is necessary to study the issues related to the digitization and marketization of information resources, to explore the modernization path of information resource management, and to ensure the sustainable development of the information industry. Therefore, this paper aims to explore the relationship between information resource digitization and marketization, analyze its impact on the development of the information industry, and provide new ideas and perspectives for related research fields. The resulting information resource industry has attracted much attention. How to incorporate individual private information resources into the information resource market? How to acquire, collect, convert, analyze and trade information resources in this process of information resource marketization? What systems are needed to regulate the information resource market? With the help of information ecology theory, this paper will grasp the connotation of the marketization of information resources, systematically analyze the subject, ontology and environment of the process, and summarize the marketization path of information resources accordingly.

2. The Connotation of Information Resource Digitization and Marketization

2.1. Concepts and Attributes of Information Resources

In December 1985, the U.S. Office of Management and Budget issued the "The Management of Federal Information Resources" (The Management of Federal Information Resources), the "Circular" from the government's point of view that the information resources include information, as well as manpower, equipment, funds and information technology and other related resources [2]. It explains that information resource is a new concept derived from the integration of the concepts of information and resource, which is ultimately a kind of information, or a subset of information, including regenerative information and perceived information [3]. In this definition, it is emphasized that information resource is also a kind of resource, and the Modern Chinese Dictionary interprets "resource" as a natural source of means of production or means of life, so it can be said that information resource also has the attribute of being utilized by human beings. However, since information resources are fundamentally different from the substances traditionally referred to, we cannot simply apply their concepts, and considering the interaction between information resources and human beings in the information ecology theory, we will summarize their unique properties into the following three points.

First, availability, which is one of the core characteristics of information resources, which has the basic requirements to become a resource, that is, information resources are information developed and organized by human beings, and the purpose of this process is to use information resources for production activities or more efficient production activities. Second, finiteness, information resources is a very limited part of the information filled with the whole environment, compared with the human information demand, the supply of information resources is still limited, so the maximum realization of information resource sharing, in order to better improve the value of information resources is the human development and organization of information resources requirements. Thirdly, it is non-competitive. Since information resources are different from consumable material resources, it will not reduce the supply of information to others because of individual utilization, it can be said that the social

marginal cost of information resources is zero, and under the effect of increasing returns to scale, the information resources will have higher value to the social economy because of higher utilization rate.

2.2. The Essence of Digitization of Information Resources

The digitization of information resources is to transform traditional paper or non-digital forms of information resources into digital forms through digitization technology, so that they can be stored, processed, transmitted and utilized in a digital way. It is emphasized to pay attention to the characteristics of different information resource types, and to combine the characteristics of resources with the needs of the times, so as to better promote the targeted research on the quality assurance of information resources^[4]. In essence, information resource digitization is to transform the information content into digital data, so that it can be recognized and processed by the computer system. Through digitization, information resources can be efficiently organized, retrieved and disseminated to achieve rapid sharing and transmission of information. Digitization also enables information resources to be interconnected with other digital systems and platforms, promoting the flow and sharing of information resources, and thus promoting the development and progress of the information society. The essence of information resource digitization lies in the use of digital technology to transform information resources into digital form, thereby realizing the efficient management, utilization and dissemination of information resources.

2.3. The Essence of Marketization of Information Resources

The marketization of information resources means that information resource managers at all levels make use of the economic levers of various interest-inducing effects to prompt information resource development and utilization organizations to care about their activities from the perspective of economic interests, and it is a means of indirectly organizing and coordinating and controlling the development and utilization activities of information resources [5]. Therefore, the essence of marketization of information resources is to develop the information resource industry under the action of market regulation mechanism, so that information resources become a kind of information commodity for trading among suppliers, demanders and intermediaries.

Under China's social market economic system, the functions of marketization of information resources are as follows: firstly, to give information resources the attribute of information commodities, to increase the degree of their circulation in the open market, and to improve the utilization rate and transparency of information resources [6]. Secondly, considering that the marginal cost of information resources is zero, its circulation in the market is the need of the exchange cost of information resources [7], the marketization can make the price response of information resources more flexible, in line with the demand and supply characteristics of the market. Again, placing information resources in a specific market helps to create a competitive, fair and orderly trading environment, thus realizing the natural phenomenon of the survival of the fittest among the enterprises (including information resource suppliers, demanders and intermediaries) that have intersection with information resources. Finally, the marketization of information resources promotes the activity of information resources in the trading market, expands the tradable range of information resources, and to a certain extent helps to realize the interests of the owners of information resources and promotes the effective incentives for the property rights of information resources.

2.4. Linkage Between Digitization and Marketization of Information Resources

In recent years, along with the continuous innovation of information technology and the emergence of information demand, China's information resources market process has developed rapidly, the diversification of information subjects, information environment digitalization, information aggregation and a high degree of processing and analysis of information itself is the embodiment of the market prosperity, but due to the access to information resources, collection, conversion, analysis, the transaction process is more complex, at this stage, China's information resources market overall The overall role of China's information resources market at this stage has not been given full play to and there are a number of problems, which are specifically manifested in the insufficient supply of high-quality information resources, low value density [8] . the lack of regulations and standards resulting in the non-standardization and blurring of information resources [9] . the imbalance between the marginal cost of the enterprise of the information resources and the marginal cost of the society, the dilemma of the pricing of the information commodities resulting in the lack of willingness to trade [10] . the security of the information resources market in the process of developing Security is difficult to guarantee [11] . Information resource supply and demand do not correspond [12] and so on.

The digitization of information resources is closely related to marketization, and the two promote and influence each other. The digitization of information resources provides the basis and support for the marketization of information, while the development of the marketization of information also promotes the depth of the digitization of information resources. The digitalization of information resources through the application of digital technology enables information resources to be stored, managed and disseminated in digital form, thus improving the accessibility and availability of information resources. This creates conditions for the marketization of information, and information resources can be more conveniently accessed, traded and utilized by market participants, which promotes the prosperous development of the information market. At the same time, the demand for information marketization also promotes the digital transformation of information resources, prompting information resource providers to pay more attention to digital management and services to meet market demand and competition. Therefore, digitization of information resources and marketization are complementary, and they jointly promote the development and progress of the information industry. In this context, studying the association between digitization of information resources and marketization helps to deeply explore the development mode and path of the information industry, and provide theoretical guidance and practical support for the sustainable development of the information economy.

3. Information Ecosystem Structure of The Digital Information Resources Marketplace

The concept of Information Ecology (Information Ecology) was first proposed by American scholar F.W. Horton in 1978, and later Thomas proposed Information Ecology, which focuses on the relationship between the informant, the information itself, and the information environment, as well as the interactions between them [13] . Since then the theory has been continuously improved and is widely used in various fields of informatics. Information resources have been mentioned for many years, and under the premise of policy calls are once again paid attention to by the industry, academia and politics, and show a rapid expansion and

spreading trend, and related research results continue to emerge rapidly. In addition to the analysis of the concept of information resources, security and other dimensions, more research focuses on government information resources, which is more results, mainly concentrated in the field of library and intelligence, news media, economic field, social governance, etc.. Relying on the interaction and coupling of information resource management of each link and each element of the ecosystem of information resource marketization, the information ecosystem architecture of information resource market is constructed, and the paths and initiatives of marketization of information resources are proposed, especially to give full play to the systemic utility of the government in the marketization of information resources, to break the monopoly of the industry, the administrative barriers and the local protection, to create a fair environment for the market competition, and to facilitate the flow of information commodities, to Encourage information consumption and expand effective demand.

The information ecosystem consists of multiple subsystems that fulfill specific relationships of information needs. According to the different components and functions, this paper presents the information ecosystem of the digitized information resource market in the form of different subsystems such as information ecosystem chain, information ecosystem, and information ecosystem [14,15] .

3.1. Core Organizational Components of The Market for Digital Information Resources

Information subject: It is the bearer of all kinds of information resource activities, including information resource suppliers, information resource demanders and information resource intermediary service providers. Among them, information resource suppliers produce and expand information resources through human wisdom, including regenerative information and perceptual information, such as scientific research laboratories, technology development organizations, etc., and their existence is the premise for the formation of the information resource market. information resource demanders are the subjects who need to apply information resources to make decisions or avoid risks in decision-making to make more favorable decisions, including, but not limited to, governmental agencies, enterprises, individuals, etc., and are the main reason for the formation of the information resource market. information resource intermediary service providers refer to those who collect, acquire, convert, and use information resources. The main reason for the formation of the information resources market. information resources intermediary service provider refers to the professional service provider that collects, acquires, converts and analyzes information resources, which mainly provides the function of screening, highly analyzing information resources and generating the corresponding report, so as to reduce the complex and time-consuming procedures in the decision-making process for the decision-makers, so as to reach the decision-making needs in a highly efficient manner.

Information environment: the free flow of information resources in the market and the support system for the existence and normal operation of the information resources market. The first is the technical environment: all kinds of information technology and technical applications, systems and platforms. the second is the institutional environment: industry standards, laws and regulations and policies on the free flow of information resources, ownership of property rights, quality norms and reasonable fees. and the third is the social environment: external factors such as human resources, capital, equipment and so on in the information resources market.

Information resources: the most core component of the information resources market formation, according to its function can be mainly divided into the following three categories: information services, including the provision of overall and specific information resources

search, organization, collection. information technology, including the construction of platforms, the establishment of the system required to build the necessary technical resource packages, etc.. information commodities, including a high degree of analysis of the demand side of the information resources related to the formation of the industry's information reports, solutions and consulting.

3.2. Core Organizational Components of The Market for Digital Information Resources

In the information ecological value chain of a specific information resource market, see Figure 1., the multi-interested subjects and their relationships are the primary consideration, i.e., the flow of information resources among the subjects, and the value of information resources is manifested through the input, transmission, conversion and output of information resources. In the value chain of information resources interaction process emphasizes the importance of two-way, focusing on the release process of information resources at the same time must also take information resources feedback into account, in line with the market from the demand side to the user side of the feedback regulation mechanism, the interaction of information resources is mainly to respond to the user's demand for information resources, information resources intermediary in the process of obtaining, collecting information resources after processing to respond to the demand for information resources, basically by the following Three scenarios: Completely satisfy the user's needs. Make certain adjustments and improvements on the basis of the user's needs.○3 Reject the user's needs [14] . Rejecting customers' needs does not conform to the principle of interest, and there are difficulties in completely satisfying customers' needs, therefore, a balance is expected to be reached between multiple subjects, that is, a balance of benefit sharing, and also realizing the balance of information ecology in the market of information resources. The process of exchange, communication and gaming of these information resources is composed of actions such as information release, absorption, screening, internalization and feedback.

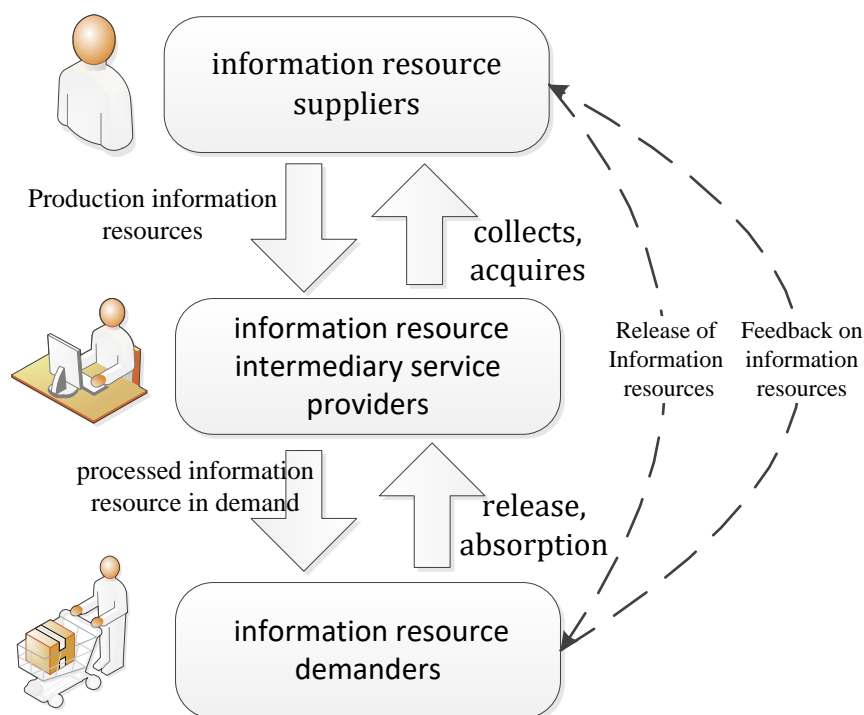


Figure 1: Interaction process of information subjects in the information ecological value chain of the information resource marketplace

In addition, it is also necessary to consider the market strategy between the subjects of multiple interests, considering the process of marketization of information resources at this stage, it is more appropriate to adopt the mixed market strategy, in order to continuously improve the competitiveness of the information subject, constantly develop new information products, and use the new products to develop a new market of information resources [16]. At the same time, it is not ruled out that in the information system resource market, the same subject will serve in multiple capacities at the same time, for example, researchers decide whether to carry out experiments in relevant aspects in the next stage through the information resources obtained from the previous experiments, therefore, the reproducibility of the subject in the information ecosystem needs to be taken into account at the same time as the strategy is selected.

3.3. Digital Information Resources Market Information Ecosystem

Referring to the Information Ecosystem Value Circle [17], it is divided into four layers as follows, see [Figure 2](#).

- The core layer is the multiple stakeholders in the market for information resources.
- The expansion layer is the participating subjects, including information collection departments: all kinds of information centers, intelligence centers, development centers, archives, libraries, cultural centers, etc.. information processing and processing departments: all kinds of information processing and processing enterprises, scientific and technological research institutes, cultural and artistic institutions, education, health, banking, insurance institutions, financial departments, tax agencies, computer centers, etc.. information transmission departments: propaganda agencies, printing, Telecommunications, news, publishing, radio, television, etc.. information service sector: information consulting companies, intermediaries, various firms, meteorological departments, talent exchange centers, etc. [18].
- The relevant layer is the participating organizations associated with information resource market activities under specific conditions, including government regulators, social organizations (universities, research institutes, industry associations), the public, etc. [19].
- The external layer is the environmental elements, which include the technological, institutional, and social environments, as described earlier for the information environment.

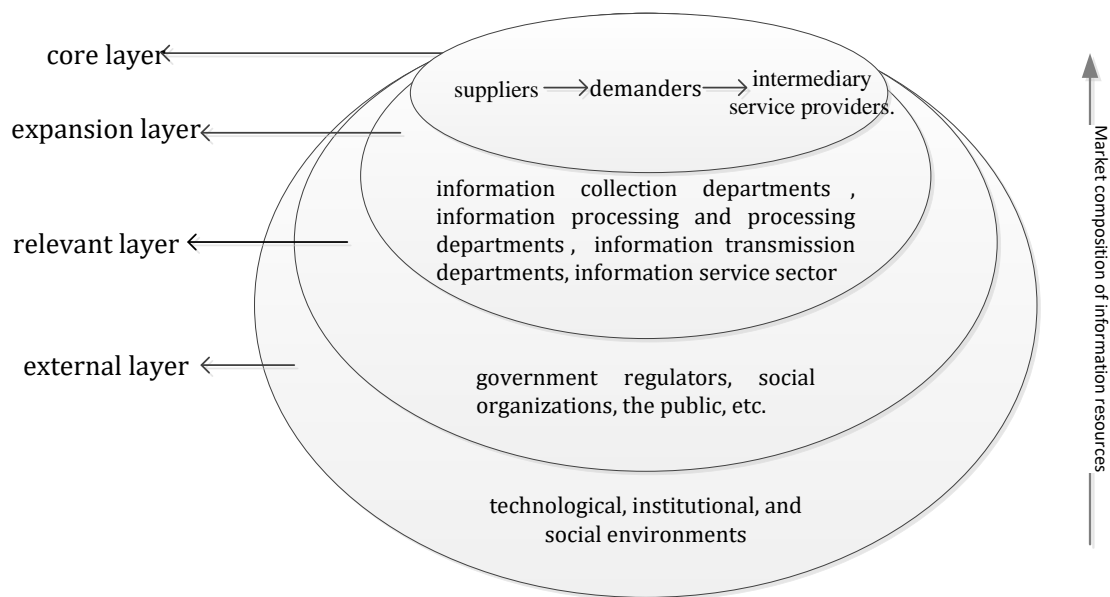


Figure 2: The information ecosystem of the information resources marketplace

3.4. Information Ecology Model for Digital Information Resources Markets

Based on the core organizational components, information ecological value chain, and information ecosphere of the information resource market discussed in the previous section, this paper fits the information ecological model of the information resource market, see [Figure 1](#), which is pulled by the external political, economic, cultural, and technological environments, and the flow of information resources is dominant in the whole process from the establishment of the information resource market to the performance of its functions. The information resource generation, collection, conversion, analysis, and development activities between the nodes of the information resource market form the information flow, whose information subjects are the suppliers, demanders, and intermediate service providers of information resources. The information ecosystem is a chain dependency of information flow between the 3 types of information subjects in information activities and the multi-interested subjects participating in market activities. Digitization of information resources in the information resources market in all segments have relevance, specifically embodied in:

Generation: The process of digitizing information resources begins with the generation of information. Digitization technology enables information to be generated in digital form, including text, pictures, audio, video and other forms. Digitized information resources are easier to store, disseminate and utilize, providing a basis for the generation of information ecology in the information resources market.

Collection: Digital technology has made the collection of information resources more efficient and convenient. A large number of digitized information resources can be quickly collected through technical means such as network crawlers and database search. Digitized information resources can be collected and integrated more conveniently, providing a rich information base for the construction of the information ecology of the information resource market.

Conversion: Digitization of information resources involves format conversion and restructuring of information. Through digitization technology, different forms of information resources can be converted into a unified digital format, which facilitates the storage, dissemination and utilization of information resources. The digitized information resources after conversion are easier to be received and processed by various systems and platforms in the information ecosystem of the information resources market.

Analysis: Digitized information resources provide a data foundation for the analysis of the information ecology of the information resources market. Through data mining, machine learning and other technical means, digitized information resources can be analyzed in depth, and the potential laws and values in the information resources can be explored. The analysis results can provide reference for decision-making in the information resource market and promote the intelligent development of the information resource market.

information commodity: Digitized information resources provide rich resources for the development activities of information ecology in the information resources market. Developers can carry out application development, service innovation and other activities based on digitized information resources, bringing more products and services to the information resources market. The development activities of digitized information resources also promote the diversification and innovative development of the information resources market.

In the information ecosystem, each information subject has clear role boundaries, but can be interdependent and transformed under special circumstances. Among them, information resource suppliers play the role of information generator, which is the starting point of an information flow, mainly generating information commodities in information resources. information resource intermediary service providers play the role of information utilizer, which is the end point of the information flow, such as actively searching for obtaining the overall or specific information resources. at the same time, information resource suppliers and information resource intermediary service providers also play the role of information disseminators, transmitting and sharing various information resources, which is the transmission channel of information resource market. all information subjects play the role of information disseminator, which is the transmission channel of information resource market. Meanwhile, information resource suppliers and information resource intermediary service providers also play the role of information disseminators, transmitting and sharing all kinds of information resources in the market, and are the transmission channel of the information resource market. all information subjects play the function of information decomposer, whose role is to organize and decompose the useless information resources in the information resource market system, to create a good environment of the information ecosystem in the information resource market, and to safeguard the information ecological balance. In addition to the information interaction between information subjects, information subjects are also influenced by the internal and external environment, especially the communication with the internal environment, which makes the information ecosystem of the information resources market face a series of technical, institutional and social problems.

After clarifying the relationship between the main body of interest, the essence of the information resources market is still the market "invisible hand" regulating mechanism, this mechanism naturally determines the market should be the main event of the dynamic trading of information resources. There are two issues that need to be emphasized here: one is that market transactions promote the development of the information resources industry, but the direction of this market-oriented process is not yet clear, and the supply and demand in the market release, the quality of information resources and pricing standards need to be regulated. secondly, the pure reliance on the market's self-regulation mechanism will make the market of information resources towards the development of uncontrollable directions, such as the information resources because of the low cost of reproduction leading to the prevalence of pirated copies of information resources. Secondly, purely relying on the self-regulation mechanism of the market will make the information resource market develop in an uncontrollable direction, such as the prevalence of piracy and low quality of information resources due to the low cost of copying, therefore, third-party regulation and institutional safeguards are needed to purge the industry of its undesirable atmosphere.

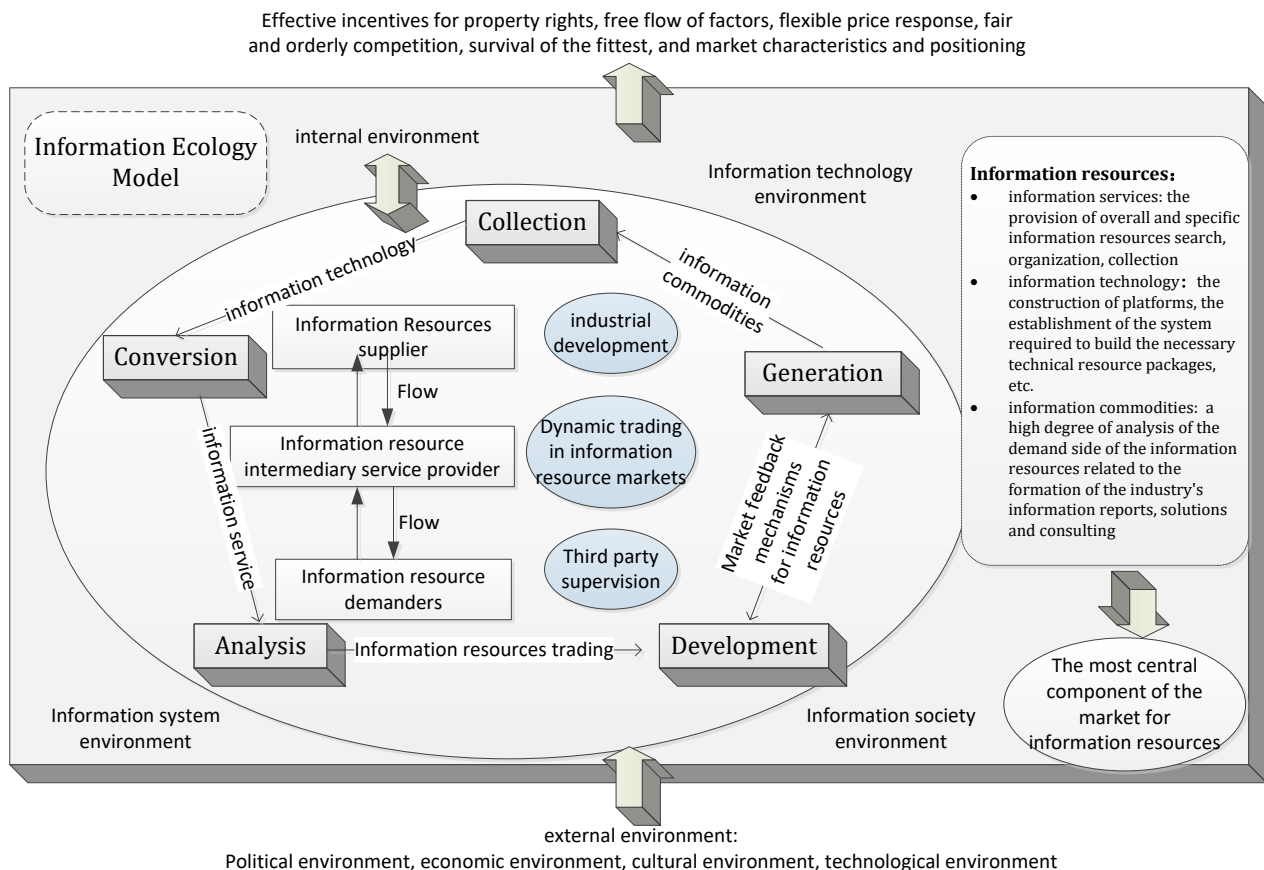


Figure 3: Information Ecosystem Model of Information Resource Markets

4. Information Resources Digitization and Marketization Path Based on The Information Ecology Model

4.1. Meeting the Basic Needs of Dynamic Transactions in The Information Resources Market

4.1.1. Improve the Construction of The Theoretical Framework and Optimize the Market Management System and Operation Mechanism

Information is an extremely important component of the social and economic factors nowadays, and the status of the information resources market in the whole environment is also obvious to all, thus, in the process of information resources marketization, it is necessary to construct a complete theoretical framework of multiple life cycles, and at the same time, innovate the resource management methods, strengthen the fine management, and match the multiple processes of information resources generation, collection, transformation, analysis, and application, and so on. In addition, the market is in urgent need of a scientific and rational operation mechanism, with process, standardization, intensification and scientization as the management goal, to establish the market transaction plan reporting, market control and approval, information resource centralization and decentralization in parallel, competition in a fair and orderly manner, and the superiority and inferiority of the enterprises and other interlocking market operation mechanisms, so as to promote the development of the information resource industry, actively develop the information resource market, and better

play the role of the market in the allocation of information resources in the basic. The basic role of the market in the allocation of information resources will be better utilized.

4.1.2. Adoption of differential pricing to promote reasonable charges for information resources

Considering the "economic man" motivation of for-profit information resource enterprises, i.e., the enterprise's motivation to maximize profits determines that it will only intervene in those information service fields that can bring economic benefits, i.e., as long as the marginal benefit of a certain information resource supply is greater than its marginal cost, there exists the motivation to supply in the market. Secondly, we also need to consider the social marginal cost of information resources i.e. the market exchange price of information resources [20] . Therefore, in the process of marketization of information resources, the price mechanism needs to be introduced, and certain charging rules need to be adopted in the for-profit development of information resources, i.e., the market supply and demand situation determines the contents, varieties and scales of the organization's operation. As a result, it is appropriate to choose differential pricing for information resources, taking into account the impact of cost and expected rate of return on the price of information resources, but not only adopting the marginal cost pricing theory or the equilibrium price theory, which is in line with the law of diminishing scale of cost-user of information resource products in the market. In addition, the marketization of information resources requires the raising of funds through various ways, especially the introduction of social capital, the expansion of the information resources trading market, giving more possibilities for the development and utilization of information resources.

4.2. Digital Technology Drives the Development of The Information Resources Industry

4.2.1. Utilizing the Techno-Economic Paradigm to Seek a Balance of Interests Among Multiple Actors

In recent years, China's economy has maintained its adjustment and development, and the demand for information resources has been increasing. Support for the research and development and application of digitization technology should be increased to improve the efficiency and quality of digitization of information resources. Intelligent revolution of techno-economic paradigm dominant logic rise, which is the new paradigm of the participating interest subjects about data technology, intelligent economy and networked production organization [21] , which will be used in the process of marketization of information resources to strengthen the research and development of digital technology application on information resources, convergence of information resources, fusion of information resources with the intelligent economy, networked production organization in one, at the same time, from the treatment of security, Policy tilt, infrastructure, education and other aspects of the entry, improve the information resources market in the construction of the talent team, co-construction of multi-participating interests in the information resources platform, as far as possible, to avoid the waste of information resources value, multi-participants between the information resources trading inactivity caused by the imbalance of interests, to accelerate the information resources development and utilization of the market process, to achieve the information resources to the socio-economic value of the transformation.

4.2.2. Cultivate and Respond to Demand for Information Resources to Match Supply and Demand

Transaction behavior in the information resource market is divided into "point-to-point" and platform transactions [22] , the former refers to the smooth matching of the supply and demand of information resources, which is obviously rare, so there are actually platform transactions in the market. In the process of marketization of information resources, on the one hand, it is

necessary to focus on cultivating the demand for information resources, on the other hand, the market should provide as complete as possible with the availability of information resources to respond to the demand that may arise at any time, and to promote the improvement of the effectiveness of decision-making. However, there are uncertainties in both the cultivation of demand for information resources and the matching of the supply of information resources. The following two ways can help to match supply and demand through the platform: one is to introduce the publicity of the information resource supply platform, and take the initiative to push the related information goods and services [23] . secondly, the service object of the information resources should be locked in the specific user groups with the ability to consume, and the pursuit of maximizing the profit, meeting the specific user needs, and seeking the supply of specific information are the important organizational goals of the main body of the market for information. For example, government departments can use outsourcing, government procurement and other specific ways to obtain high-quality, low-cost information products and services from the market.

4.3. Utilizing Regulation and Institutional Clarity to Rectify the Market Culture of Information Resources

4.3.1. Rely on Third-Party Regulation to Standardize the Quality Of Information Resources on The Marketplace

Considering the multi-source nature of information resources, if only the information resource market entities themselves cannot control the information resources circulating in the market with the characteristics of standardization and de-ambiguity, it is urgent to increase the supervision of information resources by the third party, i.e., government supervisory departments, social organizations, and members of the public, clarify the supervisory subjects and responsibilities, and carry out regular activities to rectify the quality of information resources. Through the issuance of regulations and policies, it is stated that the state has the right to regulate the scope, order and price of the development and utilization of information resources, and the standardization of information resources is guaranteed on the basis of industrial technical standards and industry norms to ensure the completeness, accuracy, timeliness, consistency and usability of the information resources and to achieve the standardization of the information resources products.

4.3.2. Provide Institutional Guarantees for Effective Property Rights Incentives

The construction of a market for information resources is a complex process, which is influenced by various social factors, such as politics, economics, science and technology, and involves a number of social institutions. The Government should introduce relevant policies to encourage and support the digitization and marketization of information resources and promote the healthy development of the information resources market. It is difficult to cultivate the market of information resources overnight, and it is necessary to establish a set of economic and social rules and regulations that match the development of information technology, and it is impossible to realize the healthy development of the market if there is no relatively perfect rules and regulations system. Therefore, the construction of information security system that meets the needs of the information resources market cannot be separated from the government's relevant institutional guarantee [24] . Sound system guarantee is conducive to regulating the interests of different information subjects, providing a good institutional environment for the establishment of the information resources market , and is also conducive to the management and supervision of the exchange of information and access to information resources. The property right system of information resources should be used to form the information resource copying and diffusion barrier, minimize the "copycat" information resources, improve the credibility of delicate resources, incentivize the production of

information resource products, and expand the scale of the existing information resource market.

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