

# Cloud-based Government Procurement Information Integration Platform

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**ABSTRACT:** *This study proposes a cloud-based government procurement information integration platform, which includes layers of physical resources, virtual resources control, and cloud services, to solve problems in government procurement information resources management, such as low shared utilization, uncommunicated information, information risk, and other issues. The cloud service layer is designed for four categories of government procurement cloud service mode, namely, infrastructure cloud, data resources cloud, and core business cloud and application cloud, which provide the IaaS, PaaS, and SaaS services, respectively. The establishment of the cloud platform plays a significant role in government procurement information storage, sharing, opening, and searching, thus cutting government spending and improving management efficiency. Such outcomes are also beneficial to the integration and sharing of government procurement information resources and business collaboration, thereby promoting innovative information resource utilization and improving information management and security.*

## Subject Categories and Descriptors

**K.6.5 [Management of Computing and Information Systems]:** Security and Protection; **K.4 [Computers and Society]**

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**Keywords:** Cloud Computing, Government Procurement, Information Integration Platform, Cloud Security Service

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## 1. Introduction

Government procurement, as a main strategy for the government and for public organizations to use state fiscal funds through a third party to purchase goods, engineering, and services, has an extremely important economic and political significance [1]. In recent years, the information construction of government procurement underwent great development as the scale of construction purchases of governments around the world expanded. In China, governments on all levels have established corresponding basic government procurement platforms and websites. However, these platforms and systems are mostly isolated from one another, and their information resources cannot be shared. Determining how modern information technology can be used to promote integration, sharing, and application of government information resources, promote rapid and healthy development of electronic government (e-government) procurement, as well as implement low cost, intensive e-government system of government procurement will become the focus and hotspots of research on government procurement information construction [2].

Cloud computing is known as the third information technology (IT) revolution. Cloud computing has virtualization technology as its core, including three service modes, namely, software as a service (SaaS), platform as a service (PaaS), and infrastructure as a service (IaaS).

Moreover, it has features such as resource shared pool, generalization access, on-demand service, and metered payment. Cloud computing can support rapid supply and release, which decreases to the minimum limit the interaction between management work and service of service providers [3]. Given the advantages of cloud computing, such as strong data processing ability and low cost, it has been applied to government procurement, which can significantly enhance the level of government purchasing informatization and e-government, improve the regulation ability, and realize service innovation. As an IT innovation, cloud computing brings to users the advantages of low cost and flexible business. However, it also brings data security concerns [4,5], which have resulted in extensive concerns from the academe.

The current paper analyzes existing e-government procurement platform problems in applying the cloud computing technology and concept to the integration and service of e-government procurement information resources, and analyzes the effect of the innovative use of resources to promote government procurement information. Finally, it describes the problems during the cloud platform trial stage and points out a future development direction.

## **2. Existing Problems in the Existing E- Government Procurement Platform**

As investments in government procurement information construction increased in recent years, various parts of China were able to fully realize e-government procurement transactions. Nevertheless, many problems on the existing e-government procurement platform still exist, including the following:

a. Vertical construction. The previous information system construction is organized as an independent information system, which makes resource integration and sharing difficult. For example, an entire modern system, including software and hardware equipment, such as server, middleware, storage, database, and application software, is constructed as soon as new business functional requirements are met. This situation causes repeated construction because the system does not require such a large processing capacity most of the time. Thus, the equipment utilization rate of resources and flexibility, coupled with concerns on Internet access, network security, increase of operations staff, and so on, which increase operational costs, are greatly limited.

b. Information isolated island. E-government procurement construction has experienced a variety of processes, from technology-driven to business-driven processes. Every business often has its own independent platform for e-government affairs. Along with the increasing number of business, this situation causes problems between e-government platforms. Currently, e-government procurement platforms throughout China are built separately, and thus different platforms have different data

formats, businesses, interfaces, and technologies, which may not be compatible. In addition, these platforms cannot fully share information resources, thereby forming an information isolated island and causing difficulties in the integration of information resources.

c. Poor system deployment flexibility. Under the existing system architecture, new business implementations usually require harmony among a number of IT systems, but the application development and coordination of this work is difficult. When legacy systems cannot meet the demands of business processing, they require further expansion. If there is still room for expansion in the original equipment, the CPU, memory, and so on are generally expanded. Otherwise, new additional equipment is often necessary, and the original business system may require migration, which is a business risk. Furthermore, when the original system goes offline, system equipment cannot be quickly deployed for other systems to use. These problems in deployment flexibility of the integration of information resources lead to additional new requirements.

d. Security risks. Owing to the funding and technology objective gap, each independently constructed e-government procurement information platform has distinct network, platform, application, and management security risks.

## **3. Advantages of the Government Procurement Cloud Platform**

Cloud computing is the development of distributed processing, parallel processing, and grid computing. Its basic principle is to put the network on the distribution of computing, storage, service components, network software, and other IT software and hardware for gathering and sharing through an open, unified way. Users are thus provided with convenient and fast on-demand technology services. Cloud computing centralizes a large amount of computing resources to constitute the pool of resources. It adopts virtualization, automation technology, and dynamic creation of virtual resources through the network in the form of services to provide for users. Cloud computing has noteworthy characteristics, such as an on-demand service, high utilization rates of resources, and strong expandability, standardization, and management.

Introducing cloud computing technology into e-government information resources integration can fully realize information resource sharing and management. Such integration will effectively solve a series of problems, including low resource utilization rate, repetitive infrastructure construction, information isolated island, repetitive information collection, unclear system connectivity, high operational cost, and security problems. It can also greatly promote the development of the government procurement system.

Construction of the government procurement platform based on cloud computing can effectively solve all the

problems in the traditional e-government platform concerning government procurement. At the same time, it can address the information construction requirements of government procurement in our country. It also promotes government procurement management and service innovations, which can lead to good economic and social benefits. The main advantages of government procurement in the cloud include the following:

a. Reduction of hardware and software input and sharing costs. Establishment of the government procurement cloud platform can encourage all government procurement agency levels and clients to use a common hardware configuration and software updates, which are provided in the government procurement cloud, rather than configuring resources to obtain the required information and services. Consequently, the use of the cloud resource integration platform as an information service is maximized and intensified.

b. Elimination of the “information isolated island” and promotion of information sharing and data exchange. At present, China’s government procurement website and electronic trading platform data are in a state of “distributed storage and access.” Information is also difficult to access. Meanwhile, huge amounts of data that consume significant quantity of the country’s manpower and resources are limited in the “information island,” which is difficult to access in a timely manner and to use effectively. The application of cloud technology can realize the organic combination of information data, distributed storage, and one-stop retrieval. Moreover, its excellent calculation ability can help users quickly find relevant government procurement information anywhere. As a result, it can enhance the efficiency of information sharing and the ability of data mining.

c. Reduction of operation maintenance and data recovery costs. When government procurement information data crash, the service quality and efficiency of the system in different areas are completely dependent on the technology and resources of its information center, leading to the difference in service capability of each government procurement actuator. Government procurement in the cloud can unite high-standard and low-cost operation management through the virtualization of centralized dynamic management and the reduction of outsourcing and leasing costs of past decentralized operations. It can likewise utilize the cloud backup of distinctive storage to recover disaster data and reduce risks of data in special cases.

d. Benefit to the safe management of government procurement. The combination of automation capabilities within a cloud with large amounts of security resources will result in advanced security capabilities [6]. Establishment of a unified cloud security system will result in the uniform management and monitoring of various business platforms that were originally dispersed. This trinity composite system of security protection, which has

cloud monitoring, protection, and audit, can greatly improve the safety level and efficiency of the government procurement information management platform.

#### **4. Building the Government Procurement Cloud Platform**

With its strength in allocating resources dynamically, storing information, and big data processing, the cloud computing environment improves the integration and service ability of government procurement information resources. To provide different scheduling levels of cloud services, as shown in Figure 6., the “Government procurement cloud platform” is built based on the management level and content of integration of government procurement information resources.

##### **4.1 Physical Resource Layer of The Government Procurement Cloud Platform**

Physical resource layer includes the computing, storage, and network infrastructures that the government procurement cloud platform needs. Cloud computing center is deployed according to the functional partition, which mainly includes computing area, data, cloud platform in reservoir management area, storage area, Internet interface area, and safety buffer.

##### **4.2 Virtual Resource Control Layer of the Government Procurement Cloud Platform**

Virtual resource control layer of the government procurement cloud platform mainly uses virtualization technology to virtualize the underlying hardware resources, as well as to achieve the efficient monitoring and dynamic scheduling of computing, storage, network, and security, among others, of a pool of resources. Extraction of the service model can realize automatic deployment, real-time monitoring, intelligent scheduling, and effective management of equipment and network resources, as well as shield the bottom hardware from failure. Therefore, this level is the key to realizing the cloud computing of government procurement.

##### **4.3 Cloud Service Layer of Government Procurement**

Cloud service layer of government procurement is based on the virtual resource control level, which provides IaaS, PaaS, and SaaS cloud services perfectly.

a. Infrastructure as a service. IaaS gathers similar resources together to build a virtual server, virtual memory, and virtual network; support a complete set of cloud security services; provide an exclusive, highly efficient, strongly expandable virtual computing center for each unit of government procurement; and realize the rational allocation of resources.

b. Platform as a Service. According to the service of standardized uniform programming interface, the data format, and service middleware, the users develop a business system that can address their diversified and customized needs conveniently and quickly. A database

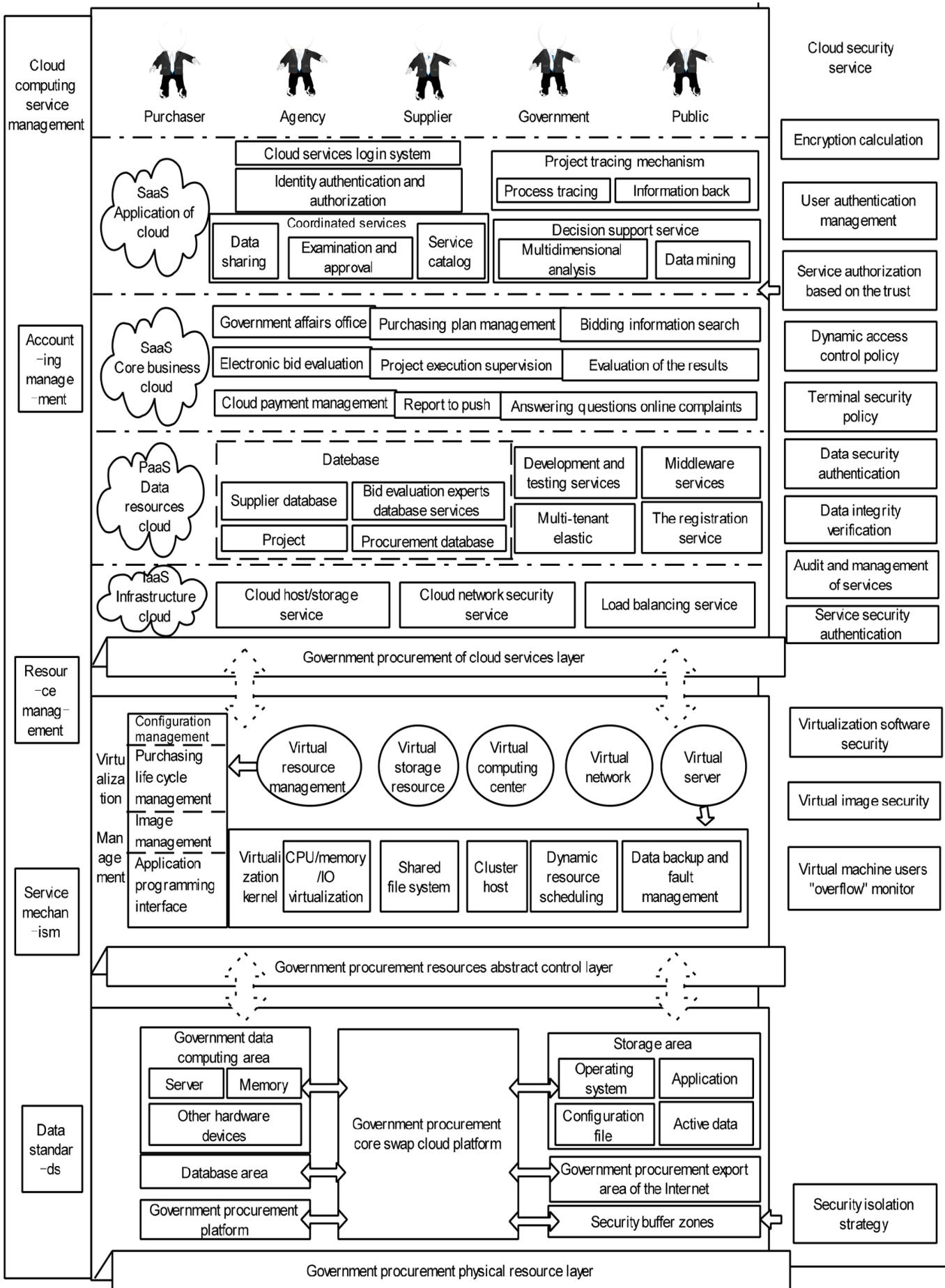


Figure 1. Cloud-based government procurement information integration platform framework

under a standard development environment will integrate the heterogeneous data resources of distributed departments to form the government procurement associated cloud database based on panel data, basic data, geographic information data, decision support data, and so on. Such database will provide the abovementioned PB structured and semi-structured cloud applications data storage and real-time access to services. For example, for the expert database in the cloud platform, when other business units develop a new system, information regarding the corresponding experts can be obtained quickly through the interface program.

c. Software as a Service. By using service-oriented architecture and workflow technology, the service cloud platform can rebuild the business process of all kinds of information resources in different regions and structures, integrated business applications, and platforms. It can also encapsulate the basic business process system into standardized cloud computing services, which fully embody the advantages of collaborative services among multiple departments.

d. Public service. The cloud platform can be utilized to build the cloud services portal and information system in a “one-stop” work style to provide information terminal services on government procurement for different users. Users, such as the public, administrative departments, and suppliers, can access varying levels of information

resource services through identity authentication and authorization. This access can help realize the maximized use of information resources on the cloud platform, and extend the sharing scope and efficiency of data resources, system resources, and incremental data.

#### 4.4 Security System Design of the Government Procurement Cloud Platform

When enjoying the convenience of cloud computing in government procurement, great importance should also be attached to the security issues, which mainly include the physical facilities, virtualization, interface standards, data-sharing technology, API security, application security, and user rights management risks. As an e-government cloud, the government procurement cloud platform carries many sensitive information resources. Therefore, improving the system design security to improve the safety of the government procurement cloud is necessary. To have an effective and strictly controlled configuration management on various “cloud” resources, decreasing the risk of information leaks in the process of information resource integration can ensure the safety of relevant data and information.

Government procurement cloud platform provides users with three aspects of cloud security services, including cloud monitoring, protection, and audit. Figure 2. presents the flexible configuration and management interface.

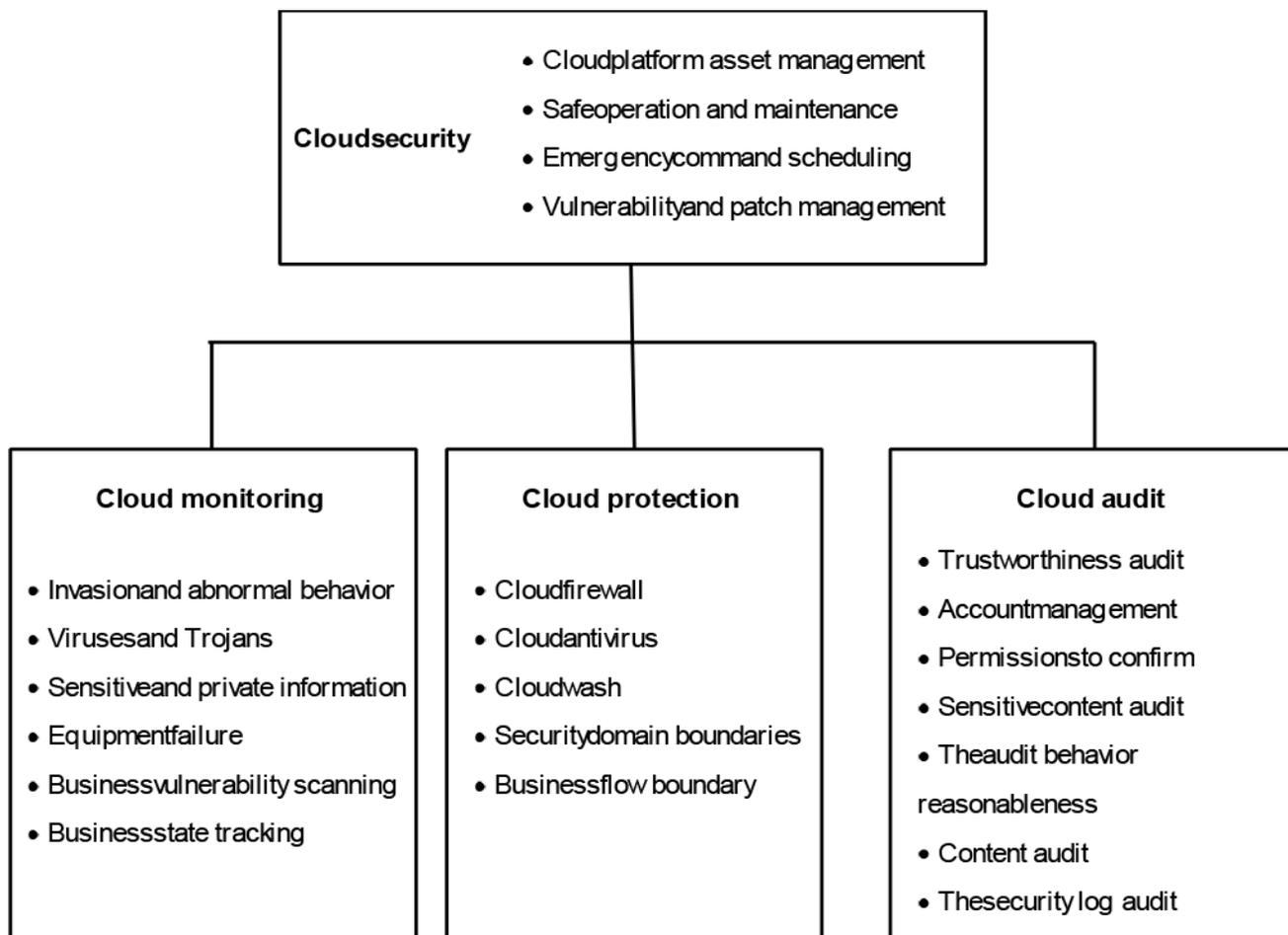


Figure 2. Security System Design of the Government Procurement Cloud

a. Cloud monitoring means the government procurement cloud platform will provide safety monitoring service for cloud servers, cloud hosting, cloud network, cloud applications, and so on, as well as provide functions like real-time monitoring of hardware failure, network security, application of leaks and push safety early warnings, and statistical statements. It will also provide a cloud security management interface, allowing users to customize the cloud detection range and the timely warning and report push strategy.

b. Cloud protection mainly includes services such as cloud antivirus, cloud firewall, and cloud cleaning. It also divides the boundary of domain security in the cloud network and boundary of business. Physical and virtual firewalls will realize the access control of external and internal cloud networks. In the meantime, cloud security management interface will support user-defined security group division and access control policies. The cloud antivirus system of the government procurement cloud adopts the model of combination in cloud host killing and virtual resource control layer killing to provide users with virus monitoring and security services. The cloud cleaning system can help more than one user at the same time to complete the denial-of-service attack's log online traffic cleaning, spam, and so on.

c. Cloud audit includes the internal audit of users and external audit regulation, which can meet the need for information system audit of all types of users. It also supports synchronous cloud storing, online inquiry, pushing statistics of the original information, data, and audit information. The content of the audit will cover credit audit, sensitive information audit, security audit, and so on.

### 5. Trial Operation of the Government Procurement Cloud

This article selects the Tianjin government procurement center as a case study. After commissioning the government procurement information integration platform based on cloud computing, not only does the platform realize the local procurement information resource sharing and application in public within this area, but it is also convenient for the government supervision and management of various resources and transaction processes, effectively preventing the occurrence of corruption. For example, Tianjin Government Procurement Cloud platform is shown as Figure 3. The cloud platform promotes Tianjin government's procurement management and service innovation and mainly includes the following features.



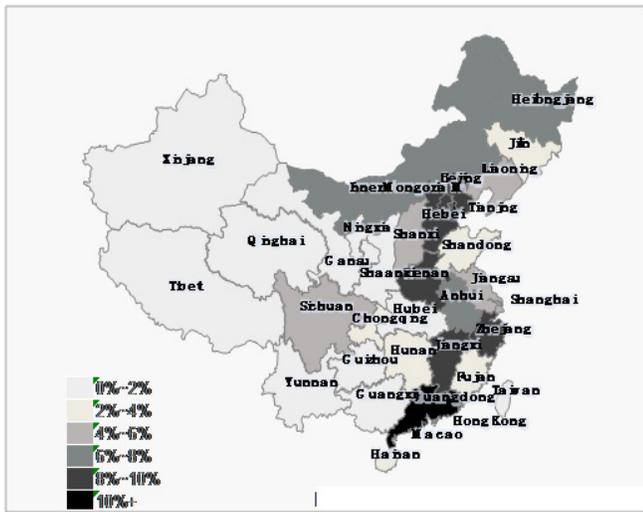
Figure 3. The webpage of Tianjin Government Procurement Cloud

First, the government procurement cloud platform will collect detailed records, including procurement requirements, procurement process, bidding results and evaluations, and so on. Analysis, disclosure, and sharing of these big data will be helpful to related departments in terms of obtaining supplier delivery information dynamically. For example, through data mapping technology, users can have a real-time understanding of the proportion of suppliers in government procurement contracts to the total share of commodity item analysis of each region in China. The darker colors in the figure below represent the

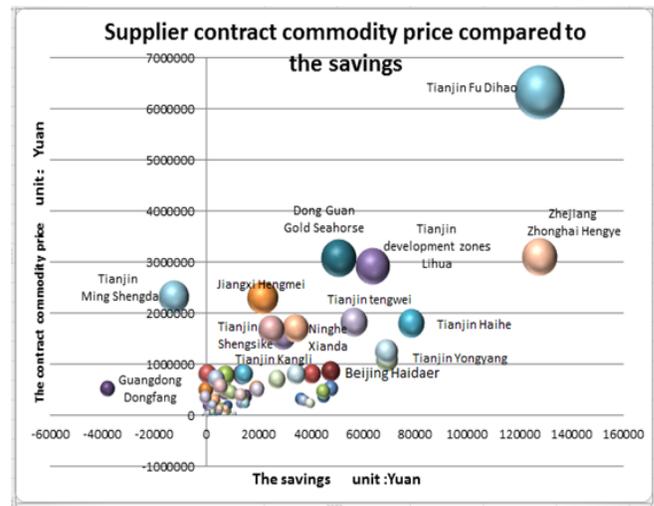
commodity contract price.

Figure 4. (a) shows the supplier source involved in the distribution of the Tianjin Municipal Government procurement of office furniture products. The main suppliers of office furniture products in the eastern region of China can be clearly identified through the deepest color, such as Beijing, Tianjin, Jiangxi Province, and Guangdong Province.

In Figure 4. (b), the bubble size represents the number of



(a)



(b)

Figure 4. Supplier source in the distribution of the Tianjin government's procurement of office furniture products

commodity prices, the horizontal axis represents the difference between the settlement and the budget savings, and the vertical axis represents the number of commodity prices. The figure shows that the Tianjin local suppliers are the most prominent. However, some bigger suppliers, such as Tianjin Fu Hao Furniture Co., Ltd. and Guangdong Hippocampus Furniture Co., Ltd., have greater total amounts of goods and finer savings than tender prices.

The application of big data technology on the cloud enables the analysis of long-term price movement of goods or services in government procurement, enhances the timeliness of procurement, improves the accuracy and quality of procurement, improves and perfect the statistical system, develops procurement requirements, and provides important scientific preparation for the procurement budget. Consequently, the efficiency of the government procurement market and of government decision making is greatly improved.

Second, various cloud services of the government procurement information integration platform can meet the personalized needs of different users. Through the utilization of large data mining technology on the access history of cloud users, log data, evaluation of procurement, and other unstructured data analysis, the database is established according to the individuation of different users. When users enter the system again, the system can automatically push the personalized business of the user according to the results of machine learning. According to requirements of different user groups (supplier and purchaser, agency, the government and the public), the system can be set up to meet the needs of their respective browsing interface, which is personalized to push cloud resources and links to contents.

Third, the responsibility tracing mechanism module of the application cloud can be achieved from the corresponding operators to the procurement plan, and finally to the procurement project completion. The process execution time, operators, and other detailed information will be

recorded in the cloud. Purchasers can check logistics information about supplies through the Internet of Things technology application of the government procurement cloud at any time. After goods are accepted through the electronic label, GPS, and sensor technology, inventory assets can be tracked to implement government procurement and the real-time dynamic management of the whole life cycle of asset management, as well as improve the level of government procurement (scientific, streamline, fine management). At the same time, the design of the transparent and standardized process can effectively prevent procurement risk and power rent-seeking.

In addition, if the government procurement cloud platform joins with electronic commerce (e-commerce) cloud platforms (TaoBao, JingDong, Amazon, etc.), and goods of government procurement cloud interchange information with the e-commerce cloud platform, parties that participate in government purchasing can dynamically grasp the market price of commodities. Hence, the degree of open and transparent government procurement is enhanced further.

## 6. Problems that Need to be Addressed

As a new e-government platform, the cloud-based government procurement information integration platform still has some disadvantages in the commissioning process, which needs further research and improvement.

a. The system standards and cloud interface lack unification. The present cloud platform system ensures regional information system unification, but because different district governments purchase electronic platforms from different suppliers, interface versatility and platform portability are poor. These concerns require further technical intervention, which can address the individual application of the SOAP protocol service of heterogeneous systems encapsulation to form standardized Web Services and realize data exchange service, service

registration, and access to the query.

b. Network bandwidth needs to be increased. The foundation of the cloud computing service is the Internet. All data and information need network transmission. As the volume and data of the cloud platform users develop further, the existing bandwidth will be under enormous pressure. Meanwhile, network latency will greatly hinder the advancement of cloud computing. Fortunately, the Chinese government is aware of this hindrance and is trying to accelerate network construction work, which can be resolved and improved in nearly one or two years. Furthermore, it can start at the technical level, through cloud monitoring and firewall technology, to implement the intelligent detection of each address service, control its program bandwidth, and limit unnecessarily large P2P and FTP file transfers.

c. Civil servants and other users need technical training. Government procurement cloud platform involves purchasers, suppliers, entrusting agents, government civil servants, the public, and other user groups. Thus, promotion of the cloud platform and training of relevant personnel must be increased to promote the application of cloud technology. Cloud users, especially civil servants, who have received cloud technology application training can play an important role in demonstrating the cloud platform application function and promoting cloud technology to expand its influence and better realize human-computer interaction during the entire process of government procurement.

Further cloud platform construction and promotion also involve numerous other factors. Comprehensive considerations, such as the size of the share, the application types, departments involved, and construction capital, all of which will affect the strategy formulation of the cloud platform's construction, need to be addressed. We also need to pay attention to the government function, industry organizations, information expert advice, overall planning of solution selection about cloud computing platform, cloud migration policy of information resource, step-by-step implementation roadmap, risk assessment and risk management, security regulatory standards proposal, and so on to reduce risks, improve efficiency, and avoid redundant constructions.

## 7. Conclusion

With the rapid development of the cloud computing technology, the flexible deployment and convenient management of such technology bring new development opportunities in government procurement information, providing new thoughts to solve problems, such as insufficient resource sharing of procurement information, difficulty in business coordination, inefficiency in resource utilization, and big data resource mining. In view of the current government procurement information construction, which faces information island, network isolation, deployment, hardware separation, high cost, and

information security, among many other problems [7], this article proposes the framework of government procurement information integration platform based on cloud computing and its security subsystem framework, analyzes the advantages of the government procurement in the cloud, and discusses the implementation of the government procurement cloud path.

The characteristics of the cloud-based government procurement information integration platform include combined standardized and personalized business, concentrated deployment of hardware facility, centralized data management, unified professional management of operation and maintenance, cost efficiency, and high safety. The platform can fully meet the information construction demand of the regional department, reduce the financial burden on the input of government procurement in information construction [8,9], enable the government procurement staff to channel energy to their core business, and reduce resource investments and operation and maintenance costs. Furthermore, it can realize data sharing to further promote the transparency of government procurement, management innovation, and service innovation, improve the efficiency of the government procurement market, and prevent corruption.

## References

- [1] Harland, C., Nassimbeni, G., Schneller, E. (2013). The SAGE handbook of strategic supply management. p 372-373.
- [2] Liao, T. S., Wang, M. T., Tserng, H. P. (2002). A framework of electronic tendering for government procurement: a lesson learned in Taiwan. *Automation in construction*, 11 (6) 731-742.
- [3] Mell, P., Grance, T. (2011). The nist definition of cloud computing, recommendations of the national institute of standards and technolog. *National Institute of Standards and Technology*, p 1044-1045.
- [4] Zissis, D., Lekkas, D. (2012). Addressing cloud computing security issues. *Future Generation computer systems*, 28 (3) 583-592.
- [5] Paquette, S., Jaeger, P. T., Wilson, S. C (2010). Identifying the security risks associated with governmental use of cloud computing. *Government Information Quarterly*, 27 (3) 245-253.
- [6] Zissis, D., Lekkas, D. (2011). Securing e-Government and e-Voting with an open cloud computing architecture. *Government Information Quarterly*, 28 (2) 239-251.
- [7] Chanchary, F. H., Islam, S. (2011). E-government based on cloud computing with rational inference agent. In: *IEEE High Capacity Optical Networks and Enabling Technologies*, Riyadh, Saudi Arabia:IEEE, p. 261-266.
- [8] Pokharel, M., Park, J. S. (2009). Cloud computing: future solution for e-governance. In: *Proceedings of the*

3rd International Conference on Theory and practice of electronic governance, New York, USA : ACM, p 409–410.

[9] Mukherjee, K., Sahoo, G. (2010). Cloud computing: future framework for e-Governance. *International Journal of Computer Applications*, 7 (7) 31-34.