Study on Intelligent Port under the Construction of Smart City

Yunjian Wu
City College
Dongguan University of Technology
Dongguan, P. R. China
13728121856@139.com

Xiaoting Xiong
City College
Dongguan University of Technology
Dongguan, P. R. China

Xiong Gang
Cloud Computing Center
Chinese Academy of Sciences
Dongguan, P. R. China

Timo R. Nyberg
School of Science
Aalto University
Espoo, Finland

Abstract—**First of all, the article introduces the relationship between intelligent port and smart city, and points out that the intelligent port is an important aspect of the smart city applications; Then, with studying on the intelligent port concept, system framework and basic function modules, the article carries on a detailed discussion on the port production management system which is one of the functional modules; finally, it points out the urgent need to solve the problems shown in the construction of intelligent port, such as data management platform construction, information security, the standardization construction and industry chain development, etc.**

Keywords—Smart City, Intelligent Port, Internet of Things

I. SMART CITY AND INTELLIGENT PORT

By means of informatization, automation, intellectualization and technology integration, the modern port gradually develops into internationalized, large-scale and systematic one, so as to further expand the port service range and innovative service models. Based on the smart city construction in our country which is in full swing, intelligent port construction can achieve information sharing between things and dynamic collaboration, improve efficiency, accuracy and visualization of port operations, and grows into a modern intelligent port which is safe and smooth and environment-oriented efficient. We should take the smart city construction as an opportunity to speed up the construction of intelligent port with independent core technology and Chinese characteristics, and strive to make domestic ports in a leading position in the world's port competition.

A. Concept of Smart City

The report of 18th Party Congress proposed the idea that we should adhere to the road of new industrialization,

informatization, urbanization and agriculture modernization with Chinese characteristics. Urbanization is repeatedly pointed out in the speech delivered by the Prime Minister Li Keqiang. He said that urbanization offered the greatest potential for development of China in the coming decades.

In January 1998, Gore, then the U.S. Vice President, first proposed the concept of "Digital Earth", namely a virtual representation of the Earth which is based on the earth coordinates and embedded vast geographic data, and where all the world's citizens could interact with a computer-generated three-dimensional spinning virtual globe with multi-resolution.

On this basis, at the end of 2008，IBM launched the "Smart Planet" strategy, which means to embed and equip sensor to various objects (grid, railroad, building, dam, oil and gas pipeline), and integrate the information by supercomputer and cloud computing, thus realizing the integration of the social and physical world.

Actually, there is no uniform definition of Smart City. It is generally recognized that smart city is to utilize information and communication technology to sense, analyze and integrate the key information of the urban core system, so as to make intelligent response to various needs of people's livelihood, environmental protection, public security, urban services, commercial and industrial activities. Smart city construction will profoundly change the city's way of operation and management, greatly promote the urban economic restructuring, improve the efficiency of urban management, and improve residents' life quality. Smart city construction, therefore, is an important measure to implement the CPC Central Committee and State Council's proposal on innovation-driven development, new urbanization, and a moderately prosperous society [3].

Based on the combination of various networks like Internet, Internet of Things, telecommunications network, Radio and TV network, and wireless broadband network, smart city is a new city development model with highly integrated intelligence

technology, high-end developed intelligence industry and convenient service as its main features. Following industrialization, electrification, informatization, intelligence is the new breakthrough of the world's scientific and technological revolution. Thus, with the opportunity offered by smart city construction, intelligent port construction is an important opportunity to enhance the port information technology in China.

B. The meaning of intelligent port

The core of smart city is to realize intellectualized and information management of the city, its overall framework includes application layer, podium layer, network layer and sensing layer as shown in Figure 1. Intelligent port is a important part of the smart city applications, and plays an more and more important role in economic development. Our world's major port has gone through three stages of information port, digital port and intelligent port. In recent years, coastal countries attach great importance to the construction of port information, and actively promote the digital and intelligent port construction.

Application layer

Emergency command, Peaceful city, Government hotline
Intelligent Transportation, Intelligent Port, Digital logistics

Podium layer

IT capacity   CT capacity   Data Center

Network layer

Communication network, Internet,   Internet of Things

Sensing layer

Wireless Access Point, cloud computing, cameras
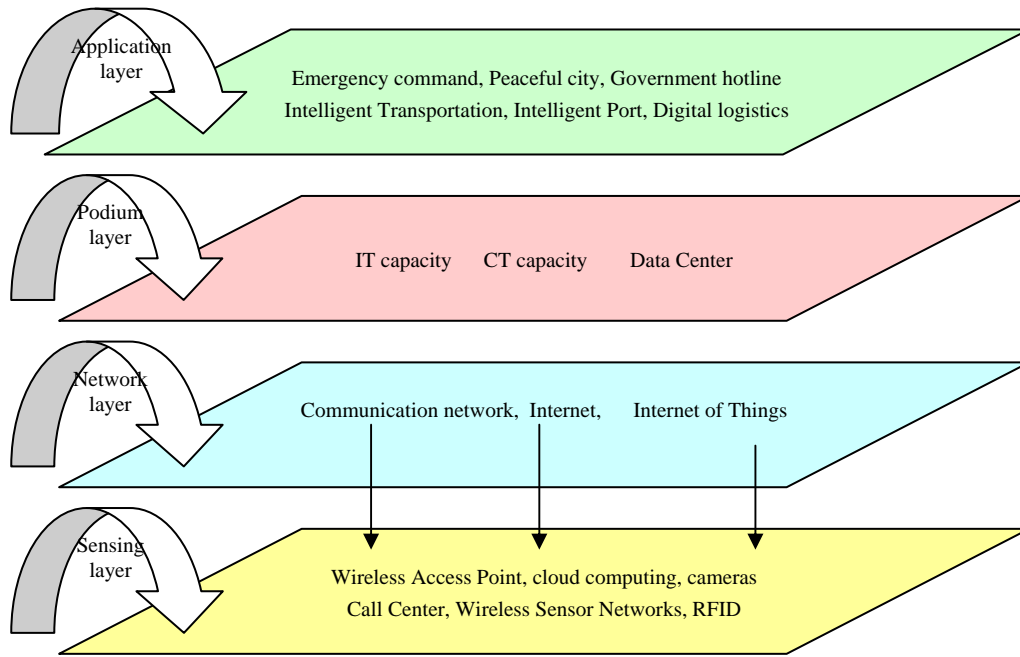Call Center, Wireless Sensor Networks, RFID

Fig. 1.   The system framework of Smart City

Europe, America, Japan and other developed countries achieved remarkable success in intelligent port construction, For example, New Damietta Port in Egypt had announced the completion of the first intelligent port among the Mediterranean ports, smart card technology and RFID technology applications in US ports provide a strong guarantee for transparent logistics, safe delivery and international anti-terrorism. There is still gap between China's intelligent port building and that of developed countries, though China's main ports have made great achievements, e.g. rational layouts, complete range of supporting facilities, high-degree modernized container transport system.

To this end, 11th Five-Year Plan of Ministry of Communications had already set the intelligent port as the goal of building and developing direction of China's modern port construction, what's more, the 12th Five-Year Plan fully deployed the intelligent port construction, and increased investment. Domestic ports, such as Shanghai Port, Shenzhen Port, Ningbo Port and other ports had also started to plan and launched intelligent port construction.   Intelligent port construction shows a trend of "Blowing up for Rain." [5-7]

However, research on intelligent port is very limited on depth, breadth and quantity as well [8-14]. The lack of theoretical research is not conducive to intelligent port construction in China. This article tries to probe in this regard.

The intelligent port is an intelligent and new kind of port management and services. Using the Internet of things technology and other technology such as RFID, sensors, wireless communications, cloud computing, 3D virtual reality technology, intelligent port would realize automatic acquisition and tracking of containers, transport vehicles and goods under supervision, and achieve information networking and synchronized data exchange of port, yard, warehousing, customs, forwarder, etc, thus forming the intelligent management of traffic flow, logistics, information flow.

Intelligent port construction can realize intelligent port logistics services and management [15], and embodies in the

following respects:

(1) Intelligent port construction can realize port logistics services computerization, networking, paperless and automation, reduce the cost of port logistics services, and improve the efficiency of logistics services and port-economic benefits.

(2) Intelligent port is able to achieve a seamless connection of ports and shipping companies, railways, roads, stations, freight forwarding, warehousing and other port-related logistics service firms, achieve information integration and sharing with logistics information platform, optimize supply chain management and improve logistics service level as well.

(3) Intelligent port construction will improve the level of port management and decision-making by ways like remote scheduling, acquisition, storage and processing of information automation, optimization of the port logistics processes and production organization, and improvement of the quality of port logistics services, etc.

(4) With the information integration of ports and customs, maritime, commodity inspection bureau and other port institutions, intelligent port construction will improve the efficiency of customs clearance and port service level.

(5) The construction of intelligent port will promote the development of port by building logistics market information service platform so as to expand port logistics market trade, finance, insurance and other supporting services.

(6) The construction of intelligent port will realize the integration of port logistics information resources to provide support for the implementation of the intelligent port and intelligent transportation systems planning.

II. THE SYSTEM FRAMEWORK AND BASIC FUNCTIONAL MODULES OF INTELLIGENT PORT

A. System framework of Intelligent Port

According to the operation model of modern port, the intelligent port system framework includes data acquisition layer, transport layer, data process layer, business layer and presentation layer, each levels are shown as follows:

(1) The acquisition layer includes operating equipment within the port area and bar code readers, RFID readers, cameras and sensors in the corresponding work area. It sense and recognizes object, and then capture and collect information for further processing.

(2) In the transport layer, the wireless Internet is connected to the management center and information center of the Internet of things, so that massive amounts of information are intelligently processed in the data process layer.

(3) Business layer is the core level of intelligent port by eventually realizing the deeper integration of information technology and intelligent port. It combines the technology of the Internet of things with intelligent port's demand, and realizes port intelligent application solutions, including ports customer service system, the port production management system, port operations management system, etc.

(4) The presentation layer refers to terminal device or mobile phone equipment used by port staff or enterprise users, and it is a way to realize the communication of intelligent port with people.
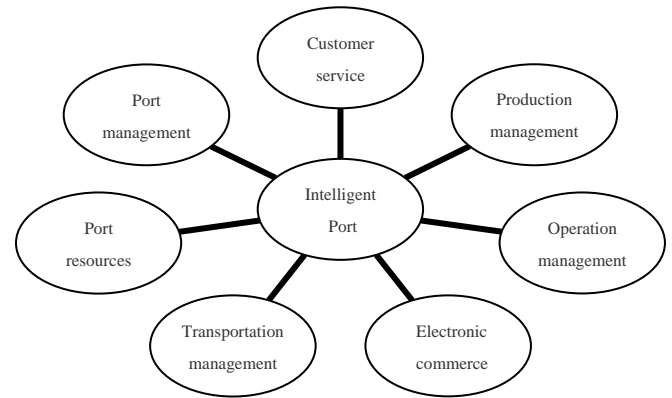

Fig. 2. Basic functional modules of intelligent port

B. Basic Functional Modules of Intelligent Port

Each port has its own characteristics, so does the intelligent port, which must be customized. However, the intelligent port has something in common, that is to provide customers with maximum port logistics information services according to the principle of "high efficiency, high-security, high-quality service". Therefore, intelligent port system should focus on the modules of customer service system, the port production management system, port operations management system, e-commerce system, integrated transportation management system, port resources management system and other functional modules

The functions of each module are as follows:

(1) Using the port logistics information platform, port customer service system provides various kinds of information, such as basic information of the port, customer service guide, the introduction of business processes, applications, etc.

(2) By data information exchange between internal network and internal port business software, the port production management system is applied to production scheduling, organization, and direction, and monitors the operating process with video surveillance technology.

(3) The port operations management system make operation decisions about market management, freight management, distribution management, customer management, security management, financial and settlement management, office automation systems, etc. It supports SMS notifications at key part of management process. Supporting the junction with attendance system and security system and offering basic data for management with electronic tag, cameras and other equipment, the port operations management system provides safeguard for security management with technology like face recognition, trajectory tracking, video moving detecting and equipments of radio, alarm, etc.

(4) Using the Internet to realize customers and port logistics related business activities and other related business, the e-

commerce system shares information by supporting its junction with other e-commerce platform, ship information systems, the trailer information systems, and warehouse and logistics company system. Enterprises can publish and update business information by e-commerce system, while customers and ports can select services according to the actual situation.

(5) The integrated transportation management system achieves docking with other transportation systems to deal with business management and decision-making of water transport transshipment and multimodal transport, so as to reduce the transit application procedures and achieve the logistics data sharing.

(6) The port resources management system uses the technology of internal information network, video monitoring, marine navigation and positioning, GIS electronic map to establish basic data graph library of port enterprise resource management and realize intelligent management of resources. It presents operation situation like port, navigation channel and driving conditions of the ship by electronic map, video and other ways.

(7) Managing the vehicles and personnel in and out of port and realizing intelligent gate function by PAS positioning communications, RFID technology, face recognition, video motion detection, trajectory tracking and other techniques, the port management system provides the customs unified port logistics information and shares information between logistics information platform and the customs EDI application system, and realizes customs clearance services integration, thus it would optimize or reduce business processes between the port and the customs and improve efficiency.

The following part will take the port production management system as example to elaborate the realization of intelligent function.

First of all, wireless network covers the whole wharf district with the application of GPS, 3G and wifi wireless communication technology, 3D simulation of reality technology, while the facilities like container trucks, forklifts, suspension bridge and crane are loaded with car wireless terminal which also possess the GPS communication functions on container trucks. Then, workers in control center use the scheduling system of 3D yard space model to send instructions for those facilities inside the port, and accept the feedback in real time as well. In addition, 3D yard space model is also updated in real time to achieve consistency between simulate mode and real yard work, and optimize control center's scheduling operations resources.

This function module mainly realizes 3D yard management, intelligent scheduling, intelligent operation, container truck dispatching and other functions. It's effectiveness and characteristics are listed as follows:

(1) It optimizes scheduling and improves efficiency by automatic operations, increasing the hoisting machinery and vehicle's efficiency, reducing the empty run, and improving their use transparency and efficiency.

(2) It realizes operation and maintenance cost down by intelligent program management of machinery and vehicles

maintenance to reduce the maintenance cost, and providing the best driving route to reduce oil consumption.

(3) It increases the safety and traceability because the safety of goods and drivers are given more reliable guarantee, historical operating trajectory and operating procedures can be played back for tracking and analysis.

(4) It optimizes the services process as shippers can take the initiative or be kept informed of the operating status of the goods, and the reaction rate of business operation is increased, and machinery and vehicles empty usage is reduced.

III. Problems to be Solved at the Construction of Intelligent Port

A. Data management platform construction

During the construction of intelligent port, various types of sensors are arranged to every corner of the port to collect all kinds of information and data, which must be orderly organized to be used for production management. Therefore, it must set up a data management platform which has unified public standard interface on information support, safety protection, purview authentication, and the platform should be able to withstand a lot of business operations concurrent processing and massive data exchange.

B. Security issues

During the construction and operation of intelligent port, security and privacy protection of data is very important. To this end, we must first set up security mechanism to protect the confidentiality of the data during transfer process, and avoid the information on electronic tags or sensors be malicious changed or revealed. Then, to ensure data's security in a broader internet as well as application-level, the system should both allow remote application system call database, and be equipped with complete encryption and authorization mechanisms.

Moreover, upgrade of the port management information system will bring vast amounts of information and data, which are stored in the port management information system in a standardized way, and when this information is stored in a data platform, we should pay close attention to information confidentiality issues.

C. Normative construction issues

Since different countries have different development level of port management information system and use different technical standards, there is information differentiation between different ports, the port and enterprises, and ports of different countries, which is why we should strengthen cooperation between countries to solve the problems of heterogeneous standard integration and information normalization.

D. Industry chain development issues

How to allocate the huge investment in port construction is a key issue that will affect the construction and sustainable development of intelligent port, since its development concerns

not only port management level but also ordinary users, such as shipping companies, traders and shippers, etc. Therefore, we must build a win-win business model to ensure the healthy and benign development of intelligent port in the open market.

IV. CONCLUSION

With the rapid development of China's economy and quickened integration of international economy, the pursuit of higher efficiency and more reliable security has become the urgent requirements of ports, and this proposes higher demand of port digital construction, namely intelligent port. The construction of intelligent port requires transparent port operation management and supervision throughout whole process, thus optimizing and upgrading the traditional logistics industry, and offering an efficient, fast, convenient, environmentally friendly and low-cost logistics service environment. This article introduces the concept and role of intelligent port, and points out that the intelligent port includes data acquisition layer, transport layer, data process layer, business layer and presentation layer. Intelligent port system should revolve customer service system, the port production management system, port operations management system, e-commerce system, integrated transportation management system, port resources management system and other functional modules. At the end of this article, we discussed the problems to be solved at the construction of intelligent port.

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