A Case Study of Mobile Popularization of Science and Technology Infrastructures in China

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Abstract--**The primary purpose of this paper is to summarize the history and status of China mobile science and technology museums, as well as the trend being predicted. The method used in this paper is documentation, theoretical analysis, investigation research and case study. It is analyzed that the mobile science and technology museums are characterized in social fund using and target audience service, and the regulations are concluded. It is also concerned that how the mobile popularization of science and technology infrastructures (including mobile science and technology museums and science wagons) promote the science popularization enterprise in China and the social impacts are also mentioned. It is providing experiences for international counterparts.**

I. INTRODUCTION

By the end of 2011, there are altogether 976 science and nature museums in China, with the increase of 6.57% comparing to 2010; and the exhibition area reaches to 2,950,660 square meters, with the increase of 5.60% comparing to 2010; and the number of visitors reaches to 107 million with the increase of 10.85%, the growth rate of the number of visitors is about twice as much as the former two [8]. From the data, we could find that, the public are paying more and more attention to science popularization, but the ratio of the number of the museums and the total number of popularization is 1:1.41 million (according to statistics, in 2011 China's popularization is 1.378 billion), from 2000 onwards, the ratio is 1: 0.75 million in UK, 1: 0.41 million in USA, 1: 0.22 million in Japan, 1:0.26 in Taiwan China [14]. We should be aware that, although the construction speed of science and nature museums in China is the quickest in the world, the total number is too small comparing with China's population. Furthermore, according to the *Development Plan of Popularization of Science and Technology Infrastructures (2008-2010-2015)* (hereinafter referred to as *Development Plan*) and the *Construction Standard of Science and Technology Museum* (hereinafter referred to as *Construction Standard*), science and nature museums should be better built in cities with more than 1 million permanent residents, cities with less than 0.5 million permanent residents are not the favorable places. In the unfavorable cities, how to satisfy people's demand for science popularization venue is a question, science wagons appeared in 2000 and mobile science and technology museums appeared in 2012. This research clears the history and status of mobile popularization of science infrastructures, analyzing its social impact, its coverage of the target population, its measures in developing and sharing exhibition and informal education resources together with the value of the Exhibit Workshop for designing and manufacturing and the different policies in the eastern China and in the Mid-west China. It also discusses the issues of financial resources, human resources and theory construction.

II. DEMARCATION OF MOBILE POPULARIZATION OF SCIENCE AND TECHNOLOGY INFRASTRUCTURES

Mobile popularization of science and technology infrastructures refer to the social welfare infrastructures made up of special vehicles and on-board equipment, exhibits, videos and hands-on activities [11]. It includes 2 categories: science wagons and mobile science and technology museums. In the *Outline of National Scheme for Scientific Literacy (2006-2010-2020)* (hereinafter refered to as the *Outline*) promulgated in 2006 by the government points out: in some cities and counties, science wagons in the form of "mobile science and technology museums" will be continuously allocated to provide science popularization service to communities and schools, especially those are located in poor and distant districts. This item is one of the three guarantees to realize the *Outline*. So in some sense, we could take science wagons as the embryo of mobile science and technology museums, mobile science and technology museums are the sustainable development, and the mobile science and technology museums in counties are the deepening forms. The mobile popularization of science and technology infrastructure is the effective complement of the fixed science and technology museums, it could break through the limitation of space, providing better science popularization services to the public, they make their respective advantages complementary to each other.

Science wagons are initially designed and assigned to locals in 2000 by the guidance of China Association for Science and Technology (CAST) together with the provincial offices [10]. By the end of 2013, 4 vehicle models have been successfully developed and 733 science wagons are running all over 31 provinces in China [4]. And the science communication activities they afford include: panels display, videos play, reading materials delivery, consultation, report, training, science show, hands-on, prize quiz, contest, specimen, free clinic etc. They provide smaller exhibitions for several days. They provide short-term services to the grass roots such as communities, villages and schools.

Both the fixed and the mobile science and technology museums aim at the communication and popularization of science and technology by way of interactive exhibits and

activities, but the latter send the exhibits to the communities and make use of the existing public infrastructures (stadium, library, school hall, youth and children's center, etc.) as its exhibiting place to achieve the greatest degree of sharing at the lowest cost. The China Mobile Science and Technology Museum Project is put in full swing by CAST in September, 2012. The theme of the project is "to experience the science". The exhibits in the project are divided into 3 items: science exploration, science and life and scientific practice with 10 subordinate items: sound and light, electromagnetism, movement of melody, charm of mathematics, healthy life, safe life, digital life, science show, science experiment and science videos [15]. Each mobile science and technology museum has about 50 exhibits which are quite portable and hands-on. It needs an indoor place about 800 m^2 to fit in [2]. For small counties, such a temporary place is not hard to be found. Normally it stays in one county for 2-3 month and then is removed and carried to another.

III. METHODLOGY

The methods conducted in this research include: documentation, case study, expert interview, comparison and summarization. We collect and read the relevant documentation about science wagons and mobile science and technology museums to get well informed about the history and status of the mobile popularization of science and technology infrastructures. We research team chooses Shandong Province and makes a 5-day investigation visiting Feicheng County, Tai'an City, Yishui County, Xiaowongshan Community, Linyi City and the Exhibit Workshop of Shandong Science and Technology Museum. Shandong Province lies in the eastern China and is very well developed, it is the cradle of mobile science and technology museums and contributes a lot to the undertakings even the CAST sends its team to learn the successful experiences in 2010, 2 year before the China Mobile Science and Technology Museum Project is conducted nationwide. So we choose it as a "typical case study" [7]. We interview the relevant experts on telephone or through colloquia to relive our doubts. We compare science wagons and mobile science and technology museums to see their difference in amount, allocation, scale, duration, financial source distribution, exhibits and activities. Summarization is to summarize and analyze all the information got so far to make it systematic.

IV. RESULTS OF ANALYSIS

A. Multilateral Co-operation Network and to be Everyone's Benefit

After the mobile popularization of science and technology infrastructure is allocated to provinces, the local association of science and technology, the education bureau, middle schools, local science and technology museums and communities cooperate to run it. Usually they set up an operational office to propagandize it on local newspaper and web portal. They choose appropriate places for the exhibition tour and arrange the handover schedule. They recruit the volunteers and the part-time employees and train them to get them competent for the interpretation and demonstration work. They also organize the visiting groups and set up the visiting timetable, giving prominence to young students and taking civil servants, community residents and the rural residents into consideration. This mobile science popularization exhibition is of everyone's benefit and obtains very high social appraisal through effective propaganda and orderly organization.

B. Play an Important Role in the Foundation of the Modern System of Science and Technology Museum

In 2013, the researchers in the field of science communication in China promote the blueprint of modern system of science and technology museum which means the mobile popularization of science and technology infrastructures, basing on the fixed science venues (especially the comprehensive science and technology museums), are overall planned and coordinate developed with specialty and digital science and technology museums [1]. The modern system plans to reach the rational distribution, advantages complementation and resources sharing targets by way of government domination. This blueprint hammers at building up a word-class public cultural service system to meet peoples' demands and fulfill the final goal of promoting citizen's scientific literacy. The mobile popularization of science and technology infrastructures plays an important role in the modern system with its coverage of residents in distant and poor districts.

C. The Sustainable Developing and the Sharing of the Resources

Exhibits resources are the soul of popularization of science and technology infrastructures. A constantly updating collection of exhibits could always attract the visitors. The China Mobile Science and Technology Museum Project plans to develop 43 new collections of exhibits every year since 2013, and the total amount would reach 172 collections by the year 2016. And the working mechanism is that: the provincial science and technology museums in Middle and West China propose the design and expenditure plan to CAST, and experts from CAST evaluate the plan and decide whether to give financial aid or not as well as how much fund will be given to the proposal. If the China Mobile Science and Technology Museum Project runs smoothly, by the end of 2016, 20 of the 34 provincial-level administrative regions in Middle and West China (altogether 1,503 poor, distant and national minority predominated cities and counties) would have got their own exhibition time, each place 2-3 months. At the same time, 561 cities and counties which are scattered in East China and unfavorable for fixed science and technology museums would promote their Provincial Mobile Science and Technology Museum Project depending on the local financial fund and the technical support from the provincial science

and technology museums [5].

The sharing of resources means that mobile science and technology infrastructures of different regions and types exchange or rent their exhibits. The operational offices set up a union, the union members list their category of exhibits, after negotiation, they exchange their exhibits or rent other's exhibits at a low cost for a short period. So the visitors could see ever-updating exhibits and not get bored, and this put every cent of the input of the exhibits to maximize output.

D. The Value of the Exhibit Workshop

To ensure the sustainable development of the mobile science and technology infrastructures, exhibits need to be periodically reconfigured. And after months or years of the exhibition tour, machinery damage and software lag-behind are inevitable, exhibits need to be repaired or renovated. The accessory of the Exhibit Workshop is indispensable. Normally it is registered as private non-enterprise unit and is under one roof of the department of resource management of the provincial science and technology museum, its human resource, finance and logistics are managed by the museum [13]. In the Workshop, a number of professional positions are involved, and the employees are trained to be specialized in one craft and know other crafts to some extent, so in the design, repair and renovation procedure, the employees could collaborate very well. For most exhibits, the Workshop does the preliminary design (including conceptual design, detailed design, drawing design and material and process design), the later assembly and the coordination work, then it hands over the complex parts processing and some technical work to professional enterprises, but the overall control is being in charged by the Workshop. For the video exhibits and the digital multimedia exhibits, the Workshop does the design, script writing and key frame production, and the rendering and synthesis are handed over to professional enterprises. The Exhibit Workshop knows quite well about the design tradition of science and technology museum, they know how to reveal the same scientific principle through different forms of exhibits. The expense is largely cut down by the Exhibit Workshop dominating in the design, manufacture and repair procedure.

Moreover, the workshop also engages in science venues construction consultation, exhibition design and exhibits innovation. it sells its idea and products to gain profit. It's some kind of technology transfer, disseminating the core technology of larger science and technology museums to smaller ones.

E. East and Mid-west, Policies are Different

In the distribution of science wagons and mobile science and technology museums, CAST implements preferential policies to the Mid-west China, for constrained by the level of economic development, exhibition resources and activities in Mid-west China is relatively scarce. The allocation principle of science wagons is to mainly support the western regions (especially the western minority regions), middle and eastern regions being also taken into account. CAST gives an allowance with the standard of east 50%, middle 80% and west 100% of the purchase cost of the vehicles, and the remaining expenses being resolved by local finance [11]. In recent years, Module II (smaller) and IV (serving for agricultural technology) science wagons are widely distributed, and from 2012, they are equipped with fixed exhibits and resource bundles. And the operation expense come from central and local finance with the portion of 22million Yuan from the former and more than 10 million Yuan from the latter [6]. The run expense of each science wagon is about 100-200 thousand Yuan each year [11].

In June 2010, the Ministry of Science Communication of CAST and China Science and Technology Museum put the China Mobile Science and Technology Museum Project into trial operation, after 1-year effort, 9 sets of mobile science and technology museums are sent to 9 counties in 9 different provinces, and the nationwide exhibition tour trial starts in July 2011. Wherever the mobile science and technology museum goes, it is welcomed and loved by local public, especially the young students, a good social repercussion has been achieved. In June 2012, the Project gets its project approval in Ministry of Finance of the People's Republic of China and obtains 10 million financial aid to develop another 3 sets of exhibits and support the already existing 9 sets' tour. In 2013, CAST and the Ministry of Finance start the Project on a national scale with the central financial support of 100 million Yuan. The practical implementation of 2013 is: resources developing expense, 100.8 million; operational expense, 1.6 million; performance appraisal, not executed; sum: 102.4 million [3]. The fund of the Project belongs to the special funds, its using is strictly audited. Measures would be taken for the purpose of making up the deficit in 2014, though it keeps on a small scale.

Policies still differ in this Project, in the Mid-west China, the exhibits are designed, manufactured and allocated with the supervision of CAST, but in the East China, the provincial office is in charge of it, the eastern provinces have more decision-making power. It's a good chance for them to promote their Provincial Mobile Science and Technology Museum Project.

Shandong Province takes the opportunity of the China Mobile Science and Technology Museum Project and maps up its own Shandong Mobile Science and Technology Museum Project. It plans to invest 20 million Yuan to fulfill the Project by the end of 2014 with the goal of building up 1-2 collection of mobile science and technology museums for every city in the province (with the sum of 17); it plans to explore the operational mechanism of Shandong mobile science and technology museums from 2014 to 2020; and by 2021, Shandong could set up a science and technology museum with the construction area over 3,000 square meters and the exhibition area over 1,000 square meters for every county [16].

V. DISCUSSION

A. Fund Resource

The mobile popularization of science and technology infrastructures depend on both the national finance and local finance, but the regulations of the collection and expenditure partition of the building expense and the operation expense default. In recent years, the academic advocates to learn from the foreign countries to change the status of the government financial fund as the only financial support, and construct a funding system made up of government budget, social donation and self-employed income [12]. In the *Outline*, the item "to encourage the social donation and further improve the tax reduction policy and related measures for its implementation to institutions and individuals who donate science popularization undertakings" is listed in the supporting conditions; in the *Development Plan*, the item "to further implement the existing tax incentives which encourage the development of science popularization undertakings, to inspire enterprises, institutions, social organizations and individuals to involve in the construction and operation of popularization of science and technology infrastructures" is also listed in the supporting conditions. And the government also introduces detailed policy, such as the *Tax Policy to encourage the development of science popularization undertakings (2003)* and the *Implementation Measures of Tax Incentives in Science Popularization Enterprises (2003)*. However, due to the cumbersome and complex approval processes, the preferential policies and implementation measures are not implemented. So form a national scale, the social donation is a quite small proportion of annual science popularization fund. For example, in 2011, the nationwide science popularization fund is 10529.7669 million, and the donation proportion is 83.98315 million, accounting for 0.79% [8]. The social atmosphere that enterprises donating science popularization undertakings could be marked with the logo of "innovation" and "excellence" has not yet been established.

B. Human Resource

The mobile popularization of science and technology infrastructures are usually operated by the local association of science and technology each with about 5-7 permanent staff, in the step of tour relay and visitors serving, the short of hands is a big problem. Especially when the visitors are crowded, organization, explanation, security and maintenance are all under heavy pressure. Normally the local association of science and technology would ask the science teachers and students from the local school to build up a volunteer team or a part-time team, but the corresponding regulations about the recruitment and management has not yet been built. When complicated situation appears, it may be difficult to deal with. Furthermore, the Exhibit Workshop is normally under the jurisdiction and command of the provincial science and technology museum, executing the unified enrollment system for all public institutions. That means, to take a permanent position, a person needs to defeat thousands of competitors in the aggregated score of Administrative Aptitude Test and Essay Writing Test. But regretfully, the survived score-talents are normally incapable of the "multi-skill" exhibit designing and manufacturing work. The Exhibit Workshop has to practice the "permanent" and "temporary" employment mechanism. The pay difference and belonging sense gap between the 2 groups need to be bridged.

C. Theory Building

In the past 10 years, the mobile popularization of science and technology infrastructures develop rapidly, and the related academic exchanges and meetings are also held, but they tend to stay in the experience-exchanging level, not reach to the theory-building level. They lack the academic depth, and avoid heated contention, resulting in low level of actual academic exchanges. Besides, we introduce and translate very little related monographs and papers from foreign countries about this issue, resulting we know very little about the developing trend, basic theory, advanced idea and good cases abroad. Furthermore, limited by the social system and national conditions, the theory and practice run smoothly abroad might not work here in China. All in all, theory building is not achieved [9]. The author wants to do the theory construction, but she is still a new hand in the field and she still needs time to polish herself.

VI. CONCLUSION

1. The construction and operation of the Mobile popularization of science and technology infrastructures is a benefit-for-all undertaking and gets warm welcome and high praise from the people. At present, mobile science and technology museums, coordinating with science wagons, provide the "experiencing the science" opportunity to school students and peasants in distant counties and countryside. It is to send the exhibits to the community, very convenient for the local public and kids to visit, promoting their interest and concern about science. The projects obtain good social effect, people getting to know CAST by visiting the exhibition they send. The projects also provide good opportunity for the local to fulfill their project of science and technology museum in counties and improve their science popularization capacity.
2. China mobile popularization of Science and technology infrastructures has been exploring for 13 years, and a set of working mechanism of developing, configuring, operating and maintaining has been built up. Basing on different regions and demands, the projects continuously develop vehicles, exhibits and educational activities, and carefully deploy tour plan: site selection, exhibits transportation and display, daily management, visitors organization and media campaigns etc. And series of rule-based, well documented systems of development, service, advocacy and incentive have been set up. It's a

great innovation of science popularization in China and worthy being learned by international peers.

3. The Science Wagon Project and the Mobile Science and Technology Museum Project have become the brand items of CAST which endeavor in full coverage and sustainable development. Taking parallel developing policies, relying on the resources of the advanced venues, setting the unique Exhibit Workshop and continuing the resource developing and sharing, China mobile popularization of science and technology infrastructures achieve great success and become one of the integral parts of the modern system of science and technology museum. But it still has hot issues to be discussed and solved in fund resource, human resource and theory building.

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