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**Case Study on P3 Failures in China**  
**Taking Hangzhou Bay Bridge as an example**

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**Abstract** Hangzhou Bay Bridge has attracted public attention as a huge-scale P3 project with billions of capital since 1990s. At the start of project designing, 17 private enterprises participated actively because of the high estimated return. However, this proud P3 project ended with its failure in 2005 with the continuous loss of its profits. This research involves showing the bridge's key issues, discovering the reasons for status quo, and analyzing the responsible parties of its failure. It also provides feasible recommendations for minimizing the bridge's loss in the future, and developing P3s' better application in China by enhancing organizational functions, strengthening VFM assessment, and innovating financing system.

**Keywords** P3; P3 failure; Hangzhou Bay Bridge; VFM assessment

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# 1 Introduction

## 1.1 Definition of P3

P3s Public-private partnerships (P3s) are cooperations between public and private sectors to to deliver infrastructure or public service. According to P3 Canada, the federal crown corporation which was created in 2009 to manage Canadian P3s and deliver maximum values, *“Public – Private Partnerships (P3s) are a long-term performance-based approach to procuring public infrastructure where the private sector assumes a major share of the risks in terms of financing and construction and ensuring effective performance of the infrastructure, from design and planning, to long-term maintenance.”*<sup>1</sup> During practical periods, public sectors — usually refers to governments do not pay for the asset until P3 projects are built. The major part of the cost would be paid through the whole life of the project on the condition that it is maintained properly and performs based on specifications. Taxpayers would not be on the hook for cost overruns, delays or any performance issues over the project’s life, because the costs are known and span the life-cycle of the project.<sup>2</sup>

## 1.2 Benefits

According to summary from World bank, P3s have broad benefits as followings.<sup>3</sup>

- P3s are good pathways for better efficiency, because exploring P3s could introduce private sector technology and innovation in providing public services.
- P3s could simulate the private sectors to deliver projects on time and within budget.
- P3s could impose budgetary certainty at predictable stage by setting present and future costs of projects over time.
- P3s could provide opportunities for local private sectors to expand through cooperation with larger international firms, and sub-contracting chances for local companies like civil works,

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<sup>1</sup> (n.d.). Retrieved July 6, 2016, from <http://www.p3canada.ca/en/about-p3s/frequently-asked-questions/>

<sup>2</sup> Scott, S. (2014, March 25). Risks & Advantages of P3 Projects. Speech presented at American Bar Association.

<sup>3</sup> Government Objectives: Benefits and Risks of PPPs. (2016, February 16). Retrieved July 10, 2016, from <https://ppp.worldbank.org/ppp/overview/ppp-objectives>

construction works, facilities management, electrical works, security services and maintenance services.

- P3s could expose state owned enterprises and government to encourage levels of private sector participation gradually, especially those are overseas.
- P3s are good way to ensure technology transfers leading to national champions that can run their own operations professional and eventually export their competencies by bidding for projects or joint ventures.
- P3s could develop economic diversification by making the market more competitive.
- P3s could accelerate the development of business and industry related to infrastructure such as construction, facilities and other support services.
- P3s could help public sectors to meet the growing need for infrastructure development without concerns about limited capacities.
- P3s could extract long-term VFM (Value for Money) through appropriate risk transfer to the private sector over the whole life of projects — design-construction-operation-maintenance.

### 1.3 Types of Partnerships

According to classification from National Council for Public-Private Partnerships (NCP3P), 16 types of partnerships are involved into P3 projects as following.<sup>4</sup>

- O&M (Operations and Maintenance) – a public sector (federal, state, or local government) contracts with a private sector to provide and/or maintain a public service. Under the private operation and maintenance option, the public sector retains ownership and overall management of the project.
- OMM (Operations, Maintenance & Management) – a public sector (federal, state, or local government) contracts with a private sector to operate, maintain and manage a facility or system providing a public service. According to this contract requirements, the public sector retains ownership of the public project, but the private sector may invest its own capital into the project.

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<sup>4</sup> Types of partnerships. (n.d.). Retrieved July 10, 2016, from <http://www.ncppp.org/ppp-basics/types-of-partnerships/>

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- DB (Design-Build) – private sector provides design and construction of a project to the public sector. The public sector owns the assets and is responsible for the operation and maintenance.
- DBM (Design-Build-maintain) – is similar to a DB excluding the maintenance of assets. Maintenance risk is allocated to the private sector.
- DBO (Design-Build-Operate) – a DBO involves a contract for design with an engineer, followed by a different contract with a builder for construction, then followed by the owner's taking over the project and operating it.
- DBOM (Design-Build-Operate-Maintain) – a DBOM combines the design and construction responsibilities of design-build procurements with operation and maintenance. The projects are procured from the private sectors in a single contract with financing secured by the public sector, while the public sector keeps ownership and retains a significant level of oversight of the operations.
- DBFOM (Design-Build-Finance-Operate-Maintain) – a DBFOM requires responsibilities of designing, construction, financing, operating and maintenance are bundled together and transferred to private sectors. Value for money assessments could be attained through life-cycle costing.
- DBFOMT (Design-Build-Finance-Operate-Maintain-Transfer) – a DBFOMT is same as a DBFOM except that the private sector owns the asset until the end of contract when ownership is transferred to public sector.
- BOT (Build-Operate-Transfer) – private sectors build an infrastructure approved by public sector, then operated the project for a specified time period under a franchise agreement with public sector, and then transfers the project to public sectors at the end of franchise period. The private sectors will also provide some of the financing, so the length of franchise must be adequate to enable private sectors to earn a reasonable return on their investment through uses charges.
- BOO (Build-Own-Operate) – private sectors build and operate an infrastructure without transferring ownership to public sectors. Ownership remains in the private sector, and there is no obligation for public sector to purchase the infrastructure or take over ownership.
- BBO (Buy-Build-Operate) – the public sectors sell the assets to private sectors, then private party makes improvements necessary to operate the project in a profitable manner.

- Developer Finance – private sectors finance the construction of an infrastructure in exchange for the right to build commercial stores, residential housing, or industrial facilities at site. The private sectors contribute capital and operate facility under government’s oversight.
- LDO or BDO (Lease-Develop-Operate or Build-Develop-Operate) – private sectors lease or purchase exiting infrastructure from public sectors, then invest their own capital or renovate, modernize and expand the project. Projects are operated under contracts between private and public sectors.
- Lease/Purchase – private sectors finance and build a new project which is then leased to public sectors. Public party makes scheduled lease payment to private sectors. At the end of the lease term, the public owns the project or purchases it at the cost of any remaining uppaid balance in the lease.
- Sale/Leaseback – the owner of a project sells its project to another entity, and subsequently leases it back.
- Turnkey – public sectors contract with private sectors to design and construct complete projects in accordance with specified performance standards and criteria agreed by both contractors. Private sectors commit to construct the project for a fixed price, and absorb the construction risk of meeting that price commitment.

#### **1.4 Global Development**

According to database of Public Works Financing, the nominal value of global P3 projects were around \$775. billion between 1985 to 2011. To be more specific, the Europe was dominant — accounted for around 47%, followed by Asia and Austria — nearly 25%. The United States and Canada stood at 8.8% and 5.8% respectively.

Considering the application of P3s, the United Kingdom is the first country to introduce P3s in delivering infrastructure and public services, and other nations like Canada is professional in this field as well.

### 1.4.1 The United Kingdom

The UK is the first country to build infrastructure by using P3s. In 1992, the Conservative government of John Major in the UK introduced the private finance initiative (PFI).<sup>5</sup> In 2012, HM Treasury introduced a new approach to public private partnerships — Private Finance 2 (PF2).<sup>6</sup> The reform of P3s reduce costs and inappropriate risks which are transferred to the private sectors, and increase value for money for the taxpayer and flexibility and transparency of the contracts.<sup>7</sup>

### 1.4.2 Canada

Canada is regard as one of nations which are successful in P3 operations widely. In 2009, the federal conservative government in Canada solidified its commitment to P3s with the creation of a crown corporation, P3 Canada Inc. According to Economic Action Plan 2013, the Government of Canada announced the implementation of a P3 screen to be applied to projects with capital costs of over \$100 million submitted by provinces, territories and municipalities for funding under the New Building Canada Fund.<sup>8</sup> From 2003 to 2012, there were 121 P3 projects with total capital of \$38.4 billion. P3s have been used to build major infrastructure projects like transit systems, such as Viva (bus rapid transit) and Ontario Highway 407.

## 1.5 Development in China

P3 was introduced in China at the end of last century after it was applied by the government of the UK, and it is the most popular approach to deliver infrastructure and public services now. From the beginning of 21 century, more than 7800 P3 projects had been approved by March, 2015, with total budget of around RMB 8.8 trillion (about \$1.35 billion).<sup>9</sup> The main

<sup>5</sup> The private finance initiative (PFI). Retrieved on 2011-11-20.

<sup>6</sup> Private Finance 2 (PF2). (2012, December 5). Retrieved July 10, 2016, from <https://www.gov.uk/government/publications/private-finance-2-pf2>

<sup>7</sup> A new approach to public private partnerships. (2012, December). Retrieved July 10, 2016, from [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/205112/pf2\\_infrastructure\\_new\\_approach\\_to\\_public\\_private\\_parnerships\\_051212.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/205112/pf2_infrastructure_new_approach_to_public_private_parnerships_051212.pdf)

<sup>8</sup> P3s and the New Building Canada Fund. (2013). Retrieved July 10, 2016, from <http://www.p3canada.ca/screening-and-advisory-services/the-building-canada-fund/p3s-and-the-building-canada-fund/>

<sup>9</sup> Jin, Y. (2015, March 3). PPP's Development in China. Retrieved August 3, 2016, from [http://wenku.baidu.com/link?url=tCQ70tDWglz5k0Ux1g5eoljTq67h1wAeSAcOQDWWtZEN-ZtmfonVpAmZWKZ4F2zYc3Mf8lKnrMppQtscpD5ZWvTy0owtbdHu61gjJ\\_it0LO](http://wenku.baidu.com/link?url=tCQ70tDWglz5k0Ux1g5eoljTq67h1wAeSAcOQDWWtZEN-ZtmfonVpAmZWKZ4F2zYc3Mf8lKnrMppQtscpD5ZWvTy0owtbdHu61gjJ_it0LO)



types of partnerships include BT, BOT, BOO, etc. In 2014, governments published guidance for using P3s in terms of financing, construction and responsibilities at national, provincial and municipal levels. Also, in December 2014, China's Ministry of Finance announced that Public-Private Partnerships Centre was established. This organization is responsible for policy analysis, consulting & training, capacity development, financing support, information collection and international communication.<sup>10</sup>

## 2 China's Policy Framework

P3 was introduced in China at the end of last century. However, no regulation or guidance for both public and private sectors to participate in infrastructure projects had been published until 2014. In December, 2014, national government — the State Council made announcements to encourage innovation in infrastructure field. Then the Ministry of Finance and National Development and Reform Commission published the specific P3 guidance in terms of requirements, financing, capacities and practical application. Then the provincial and municipal regulations were released gradually based on different conditions.

### 2.1 Policy Support

Governments at different administrative levels regulate P3s differently.

#### 2.1.1 National Level

Regulations and guidance at national level are mainly published by the State Council, Ministry of Finance and National Development and Reform Commission.

The State Council published 3 regulations between 2013 and 2015. The 'Guidance for Strengthening Construction of Infrastructure'<sup>11</sup> was published on September 6, 2013, with highlights of innovation on investment & financing system and development of market resource

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<sup>10</sup> Introduction. (2014, December). Retrieved July 20, 2016, from <http://www.cpppc.org/pppjgs/index.jhtml>

<sup>11</sup> "Guidance for Strengthening Construction of Infrastructure." The Central People's Government of the People's Republic of China. State Council, 6 Sept. 2013. Web. 14 July 2016.

allocation. It provided government's administrative support for raising capital in infrastructure delivery and encouraging private sectors to participate in public projects. On May 19, 2015,

'Guidance for development of cooperation between the public and social sectors in public service'<sup>12</sup> was introduced to promote P3 application in broader sections including energy, transportation, water, environment, agriculture, forestry, technology, health care, education, etc. This enforced governments to improve policies, standardize process and provide more powerful support in terms of funding, lands and taxation, in order to protect interests of public and private sectors. Then 'Guidance for Accelerating Development of Financial Leasing Industry'<sup>13</sup> was published on August 31, 2015. It aimed to push financial leasing industry moving forward and boost economy steadily by five policy options – improving policy system, improving taxation system, innovating financing system, improving public services and cultivating the talents.

The Ministry of Finance started to introduce regulations of P3 application from 2014. The 'Operational Guidance for Public-Private Partnerships (Trial)'<sup>14</sup> was published on November 29, 2014, in order to ensure P3 project qualities by providing standards for each part of processes, including project identification, preparation, procurement, implementation and transfer process. Then the Ministry of Finance published 'Implementation of Public-Private Partnership Demonstration Projects'<sup>15</sup> on November 30, 2014. It included 30 P3 projects. All implementation processes would be reported to the Ministry of Finance based on demonstration purposes. These P3 projects ensured P3 method repeatable and promotable. Then on December 30, 2014, 'Guidance for Public-Private Partnership Contract Management (Trial)'<sup>16</sup> was approved which required more powerful contract management during drafting, consulting, execution, changing, discharging, transfer and termination. It was important to do reasonable consultation, risk allocation, fulfilling duties and protect rights. In 2015, Ministry introduced 'Guidance for Public-Private Partnership Financial Capacity'<sup>17</sup> to provide feasible and effective

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<sup>12</sup> "Guidance for Development of Cooperation between the Public and Social Sectors in Public Service." The Central People's Government of the People's Republic of China. State Council, 19 May 2015. Web. 14 July 2016.

<sup>13</sup> "Guidance for Accelerating Development of Financial Leasing Industry." The Central People's Government of the People's Republic of China. State Council, 31 Aug. 2015. Web. 14 July 2016.

<sup>14</sup> "Operational Guidance for Public-Private Partnerships (Trial)." Ministry of Finance. Ministry of Finance, 29 Nov. 2014. Web. 14 July 2016.

<sup>15</sup> "Implementation of Public-Private Partnership Demonstration Projects." Ministry of Finance. Ministry of Finance, 30 Nov. 2014. Web. 14 July 2016.

<sup>16</sup> "Guidance for Public-Private Partnership Contract Management (Trial)." Ministry of Finance. Ministry of Finance, 30 Dec. 2014. Web. 14 July 2016.

<sup>17</sup> "Guidance for Public-Private Partnership Financial Capacity." Ministry of Finance. Ministry of Finance, 7 Apr. 2015. Web. 14 July 2016.

way to analyze government's financial capacity which was necessary for raising capital and risk allocation. In addition, Ministry of Finance also analyzed the probability of P3 application in broader public service field, such as sewage treatment and road toll. These regulations provided P3 stakeholders with more detail in terms of financing, maintenance, risk allocation and responsibilities clarifying.

The National Development and Reform Commission introduced the 'Guidance for Public-Private Partnerships Development'<sup>18</sup> on December 2, 2014, with illustrations of how to capture true values of P3s, how to understand principles of P3s, how to identify the scales and types of cooperation, how to improve governments' administrative framework, how to strengthen P3 projects management, and how to enhance policy support. Then, 'Regulations on Infrastructure and Public Service Franchise Management'<sup>19</sup> was published on April 25, 2015, and effected on May 1. It focused on related agreement management including signing, performance, changes, termination, supervision, common interests protection, dispute resolution and responsibilities clarifying.

Other national governments, like Ministry of Transportation, State Administration of Taxation, Ministry of Water Resources and Ministry of Agriculture, published P3 relevant regulations to improve China's P3 application system.

### **2.1.2 Provincial and Municipal Level**

There has been 7 provincial governments that have introduced their own provincial guidance for P3 application based on national regulations. Thereafter, P3s were used broadly in transportation, health, water supply and waste treatment sectors. For example, Department of Housing and Urban-Rural Development of Anhui Province introduced the 'Guidance for Public-Private Partnership application in infrastructure projects'<sup>20</sup> on September, 2014. Then P3 Projects were implemented with total capital of RMB 7.1 billion. The investment was mainly for transportation sector with RMB 5.4 billion.

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<sup>18</sup> "Guidance for Public-Private Partnerships Development." National Development and Reform Commission. National Development and Reform Commission, 2 Dec. 2014. Web. 14 July 2016.

<sup>19</sup> "Regulations on Infrastructure and Public Service Franchise Management." National Development and Reform Commission. National Development and Reform Commission, Sept. 2014. Web. 14 July 2016.

<sup>20</sup> "Guidance for Public-Private Partnership Application in Infrastructure Projects." Baidu Library. Department of Housing and Urban-Rural Development of Anhui Province, Sept. 2014. Web. 14 July 2016.

## 2.2 Operational Process

Figure 1<sup>21</sup> shows that 5 steps are involved in China’s P3 operational process — project identification, preparation, procurement, implementation and transfer.

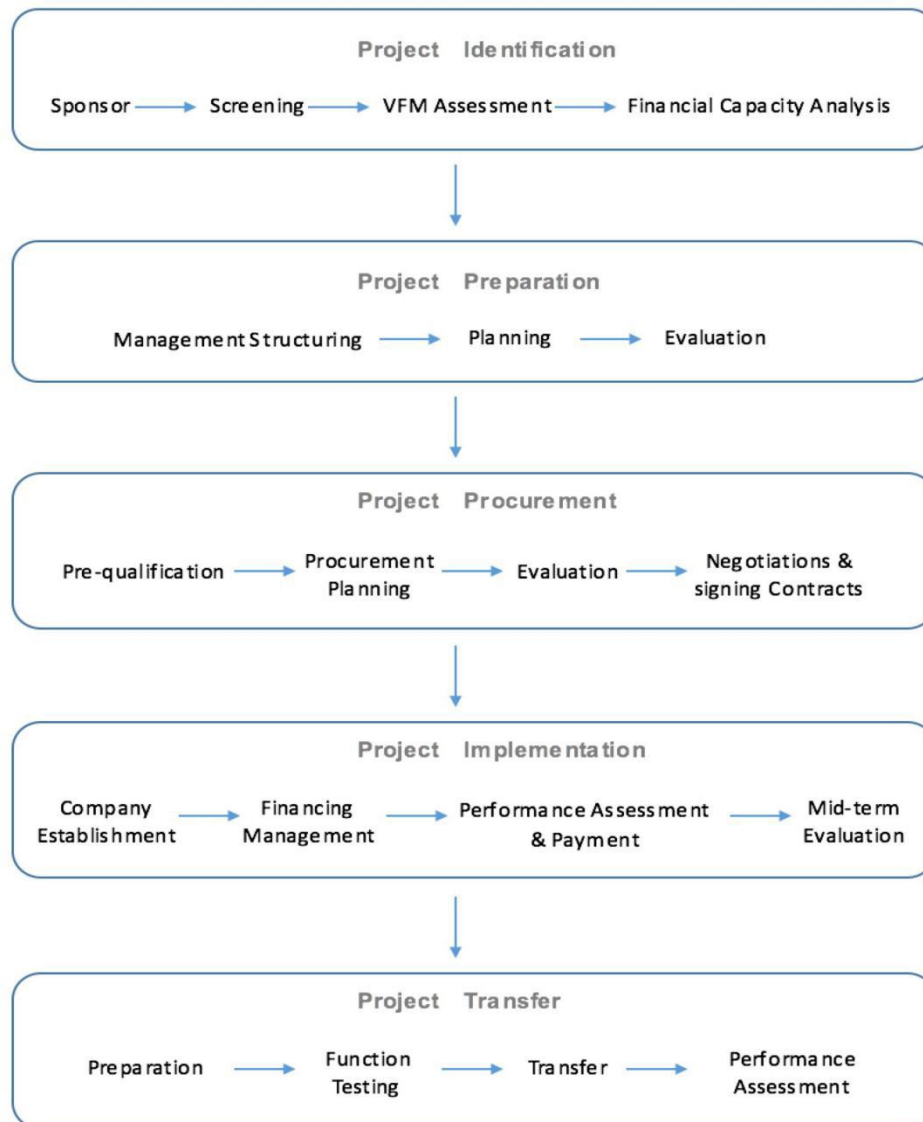


Fig1. China’s P3 Operational Process

<sup>21</sup> Lin, L. (2016, June 26). PPP’s Implementation Process. Retrieved August 4, 2016, from <http://www.chinathinktanks.org.cn/content/detail?id=2989983>

### 3 Project Case Study Overview

#### 3.1 Project Case Study Background

Hangzhou Bay Bridge (Figure 2)<sup>22</sup> is a highway bridge with a cable-stayed portion across Hangzhou Bay in the eastern coastal region of China, connecting the municipalities of Jiaxing and Ningbo in Zhejiang Province. The partnership type of the bridge is BOT (Build-Operate-Transfer). The franchise period is 30 years.



Fig2. Location of Hangzhou Bay Bridge

Preparation started from 1993. Almost 600 experts spent around a decade doing feasibility studies and designing the bridge. Construction was begun on June 8, 2003, and was completed on June 14, 2007. After a considerable period of testing and evaluation, the bridge

<sup>22</sup> Google. (n.d.). [Google Maps location for Hangzhou Bay Bridge]. Retrieved August 4, 2016, from <https://www.google.ca/maps/place/Hangzhouwan+Crossing+Sea+Bridge/@30.469658,121.1157263,17z/data=!3m1!4b1!4m5!3m4!1s0x344d32d09faf6649:0xa8318047abd92b0f!8m2!3d30.469658!4d121.117915?hl=en>

was opened to the public on May 1, 2008.<sup>23</sup> Hangzhou Bay Bridge was among the ten longest trans-sea bridges at that time, at nearly 36km (22mi) in length. The bridge shortened travel distance from 400km (249mi) to 180km (112mi) between Ningbo and Shanghai, and reduced travel time from 4 to 2 hours.

Capitals were raised from private sectors and banks as loans with 35% and 65% respectively. The project had gone well as expected until public sectors became the biggest shareholder in 2005. Thereafter, public sectors were faced with capital shortage which means the bridge tended to be failed.

### 3.2 Project Investment

Construction of the trans-sea bridge was regarded as an indication of China's increasing economic power, and it was expected to boost economic development in the Yangtze River Delta, the area which is also called the Golden Industrial Triangle. The total project cost was around CNY11.8 billion (\$1.42 billion), and approximately CNY149 million (\$18 million) was contributed by 17 non-government firms. It was predicted that the capital costs of this project would be recovered in around 15 years with ROI (return on investment) at 12.58% (including construction period).<sup>24</sup>

To simplify project implementation, Ningbo Hangzhou Bay Bridge Development Co., Ltd was established by 17 private enterprises on October 17, 2001. The new company was responsible for bridge management over the whole life cycle, including preparation, financing, construction, operation, maintenance, and transfer. Also, it was in charge of managing related materials and ancillary facilities.<sup>25</sup> At the end of 2001, private sectors held about 80% of total shares, with Youngor Group being dominant at 45%.

In 2003, Youngor Group sold 40.5% of its total shares to other private enterprises and remained only 4.5%. Meanwhile, Songcheng Group took over 17.3% of shares from Youngor

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<sup>23</sup> Li, B. (2015, May 2). Analysis of Hangzhou Bay Bridge's Financial Plan. Retrieved August 4, 2016, from <http://www.doc88.com/p-5109503915336.html>

<sup>24</sup> World's longest sea bridge to open in east China. (2008, May 1). People's Daily Online. Retrieved July 15, 2016, from <http://en.people.cn/90001/90776/90884/6402247.html>

<sup>25</sup> Introduction. (n.d.). Retrieved July 18, 2016, from <http://www.hzwkhdq.com/about.html>



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Group.<sup>26</sup> Private sectors were still the major shareholders after shares transfer. However, private enterprises started to divest capital from this project after Youngor Group’s big deal.

In 2005, Songcheng Group quitted from the project, and Sinosteel Corporation — a corporation supervised by State-owned Assets supervision and Administration Commission took Songcheng Group’s shares over. After this, public sectors were becoming the main shareholders, which broke the basic P3 principle that requires public sectors play leading role after franchise period. In other words, the result of shareholder changes meant Hangzhou Bay Bridge project turned towards failed. By the end of 2005, governments held over 80% of total shares — the figure almost doubled than that in 2001.<sup>27</sup>

Figure 3 shows the changes about financing structure.<sup>28</sup>

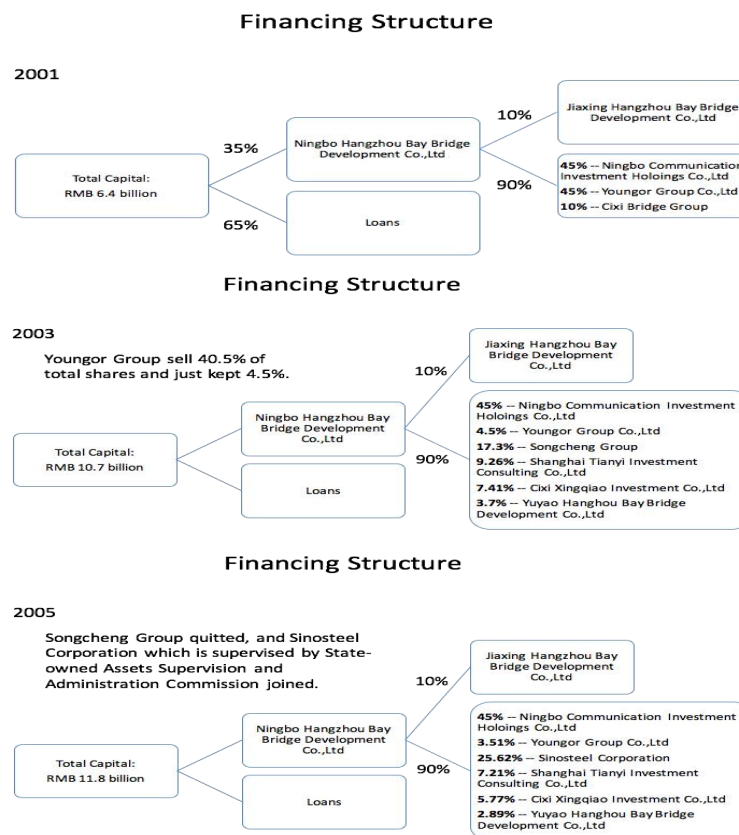


Fig3. Financing Structure Changes between 2001 and 2005

<sup>26</sup> Lai, J. (2013, December 15). Financial Plan for Hangzhou Bay Bridge. Retrieved August 4, 2016, from <http://wenku.baidu.com/link?url=T0KZZbcRPEpyNd9gDqvGeVNjJNwF2Qz5iyMC13oLGOayOu-YtFdRb50PNZSyTLyMkxUX7zK0QQZ-ynrE2y9wpbFwoKKOTjLMnFsmX79hMW>

<sup>27</sup> Are P3s really good? Super huge project started to loss money. (2015, October 16). Retrieved August 4, 2016, from <http://www.wtoutiao.com/p/Q8fbaR.html>

<sup>28</sup> Xiao, X. (2013, September 23). Private sectors quitted from Hangzhou Bay Bridge due to 5-year loss. Finance Sina. Retrieved August 4, 2016, from <http://finance.sina.com.cn/china/dfjj/20130923/021916817910.shtml>

### 3.3 Project Stakeholders

Stakeholders involved in this project are ranging from national to personal level. They are: cities of Jiaxing and Ningbo, local economy, touring industry, Government of Ningbo, Government of Jiaxing, Department of Transportation, Department of Communication, Ministry of Housing and Urban-Rural Development, construction company, gasoline company, material supplier, technology company, private investors, drivers, and passengers.

## 4 Key Issue

According to the description of P3 success from P3 Canada, there are three criteria defining when P3s are right choices.<sup>29</sup> First of all, P3 success means the total benefits exceed the costs. The next criterion is that some, or all risks of the project, including design, build, finance, operation and maintenance period, are transferred to the private sectors. Then VFM (value for money) is required to estimate whether P3 is a right choice by comparing the estimated total costs of delivering an infrastructure project using a P3 to the costs of delivering the project using a traditional delivery method. China has the same criteria to assess whether P3 projects are successful. It is obvious that Hangzhou Bay Bridge is a traditional P3 failure from following three aspects.

The biggest contributor to project's failure is that the Bridge got into debt of CNY 85 million (\$13.71 million) in 2013 mainly due to private sectors' divestment. This means that the project was faced with capital shortage as the private sectors quitted from the project. Public sectors occupied 85% of total shares in 2012, almost doubled than the figure in the very beginning of the project. Since the project was faced with intense financial pressure, private sectors suggested to close relevant unnecessary facilities, such as Haitianyizhou Sightseeing Platform which was located in the middle part of the bridge. The platform provides ideal places

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<sup>29</sup> Frequently Asked Questions. (n.d.). Retrieved July 17, 2016, from <http://www.p3canada.ca/en/about-p3s/frequently-asked-questions/>



for viewing, shopping, food & accommodation, and conference. But the reality of years of high loss at RMB 50 million to 60 million per year made non-government enterprises close it to reduce costs.<sup>30</sup>

Since private sectors divested, public sectors became the major shareholder. Hence, risks used to be responsible by private investors, then were transferred back to the government. This was against P3 principle that the majority of risks of P3 projects should be transferred to private sectors.

In addition, government did not do appropriate VFM (value for money) assessment and overestimated ROI (return on investment). The original ROI was 12.58% (including construction period) with 15-year recovery period. However, public sectors adjusted ROI several times after construction — this is the main reason that private sectors divested. ROI was under 4% in 2011. Total costs cannot be recovered after 30-year franchise period.

## 5 Causes

It seems that private sectors' divestment was the main cause for the Hangzhou Bay Bridge failure. In fact, the failure is a result of many aspects, including local economic fluctuation, government discredit and contract breaking.

The main reason for primary issue — unable to make ends meet is rising cost of materials. Considering the project structure — cable-stayed form, the major raw materials for bridge construction were steel and concrete. However, the price of steel showed an increasing trend during construction period due to unstable local economy. The total consumption of steel and concrete were more than 800,000 tones and 2,400,000 cubic meters respectively. Considering huge consumption of raw materials, costs could be effected significantly once unit prices changed. To highlight the changes, PPI (producer price index) was important. 'A Producer Price Index (PPI) measures the average changes in prices received by domestic producers for their

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<sup>30</sup> Survey on Hangzhou Bay Bridge -- severe financial stress after five years of operation. (2013, September 23). 21ST CENTURY BUSINESS HERALD. Retrieved July 20, 2016, from <http://news.qq.com/a/20130923/001301.htm>

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output.<sup>31</sup> Movements of PPI from certain period to another usually are shown as percent changes, and positive changes express price rising. For example, an increase of 10 percent from the base period is shown as 110.0, which could be explained as prices have risen from \$100 to \$110 today. Figure 4 shows how prices of materials changed during construction period in Zhejiang Province.<sup>32</sup>

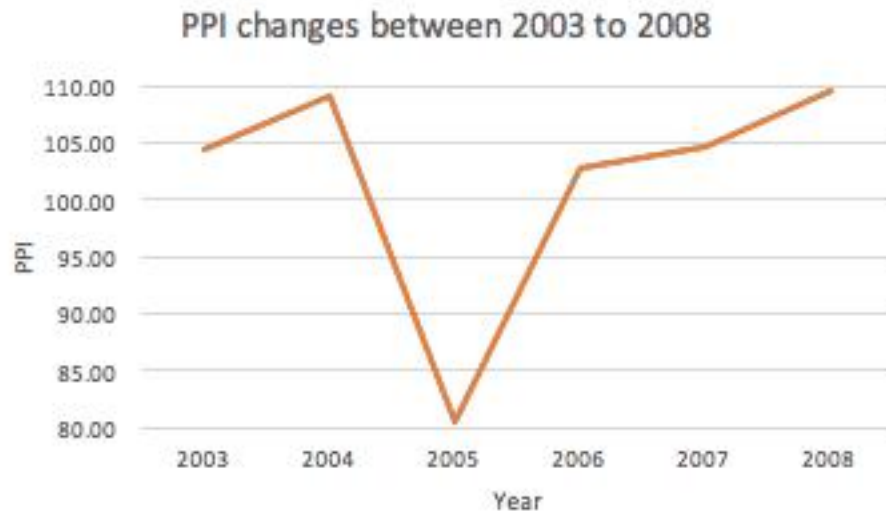


Fig4. PPI changes in Zhejiang Province from 2003 to 2008

According to China's analysis of steel prices, the main reason for steel price rising was the big gap between international price and national price. Since steel price in international market were much higher than that in China's internal market, steel suppliers were inspired to make more profits by export. Steel amount cannot meet national demand of construction, so the price increased. But in 2005, the State Council cancelled the tax rebates on export of steel materials, so there was a drop at that time.<sup>33</sup> Prices were higher in 2008 than figures in 2003 generally. Meanwhile, price rising is also as a result of inflation which should be estimated reasonably under the contract. In this bridge case, to deal with effects of inflation, there are

<sup>31</sup> Producer Price Index. (2015, January 24). Retrieved July 18, 2016, from [https://en.wikipedia.org/wiki/Producer\\_price\\_index](https://en.wikipedia.org/wiki/Producer_price_index)

<sup>32</sup> Qi, X., Ke, Y., & Wang, S. (2009, October 12). Analysis on Critical Risk Factors Causing the Failures of China's PPP Projects. CHINA SOFT SCIENCE, 5, 107-113. doi:10.3969/j.issn.1002-9753.2009.05.014

<sup>33</sup> Zhang, Z. (2005). Analysis of China's Steel Price Changes in 2005. Price: Theory & Practice, 07, 26-27.

formulas including in contract to adjust prices once inflation occurs.<sup>34</sup> However, I did not get such confidential information.

Another significant cause was government discredit. At the design stage, ROI was estimated as 12.58% with 15-year recovery. The primary income during operation period was from tolls. According to VFM assessment, there would be more than 19,500 vehicles/day with toll of RMB 80/vehicle. Private investors could get recovery in the first 15 years of 30-year franchise period, and make profit of more than RMB 12.3 billion before the project being transferred to governments. From the start of operation to May, 2010, more than 19 million vehicles had passed through the bridge with total income of RMB 1.5 billion. And it was predicted that ROI would be stable as long as there would not be competitors.<sup>35</sup> However, government broke the contract and started to build similar across-sea bridge — Jiashao Sea Bridge, connecting Jiaxing and Shaoxing and spanning Hangzhou Bay, was begun in December 2008 and completed in June, 2013. The new bridge was open for traffic on July 20, 2013 with toll of RMB 40/vehicle, which is only half of the price for Hangzhou Bay Bridge. Figure 5<sup>36</sup> shows locations of Jiashao Bridge and Hangzhou Bay Bridge. Figure 6<sup>37</sup> and 7<sup>38</sup> show how vehicle amount of Hangzhou Bay Bridge and Jiashao Bridge changed after Jiashao Bridge was completed. Apparently, there was a significant drop in Hangzhou Bay Bridge's traffic flow and toll income, while Jiashao Bridge had a gradual increase in traffic flow. I supposed to compare how traffic flow and toll income of Hangzhou Bay Bridge changed before and after Jiashao Bridge was open, to make clear how Jiashao Bridge effects. But I did not have access to sufficient data due to information confidentiality. So I just listed the data I have gotten. However, we can still tell from exiting data that Hangzhou Bay Bridge had only two third of vehicles as many as the expected figure after Jiashao Bridge started to operate. Because of this, private

<sup>34</sup> Zhan, X. (2011, September 22). Risk Analysis for Hangzhou Bay Bridge. Retrieved August 20, 2016, from [http://wenku.baidu.com/link?url=9fulMefcEOqOzlerkCAqLTs1Hijn0MV-v9rojWj2M0w3aVoskx9yKWQnZXE90U0JfEzklPlb1YIIn8\\_kWsj2iqTsMKIysqxEyItRdx3wC](http://wenku.baidu.com/link?url=9fulMefcEOqOzlerkCAqLTs1Hijn0MV-v9rojWj2M0w3aVoskx9yKWQnZXE90U0JfEzklPlb1YIIn8_kWsj2iqTsMKIysqxEyItRdx3wC)

<sup>35</sup> Jiang, C. (2012). General process and cost analysis of financing -- Taking Hangzhou Bay Bridge as an example. *Knowledge Economy*, 19, 93-93.

<sup>36</sup> Goggle. (n.d.). [Google Maps directions for Hangzhou Bay Bridge and Jiashao Bridge, China] Retrieved August 16, 2016, from <https://www.google.ca/maps/place/Jiashao+Bridge/@30.2562735,120.7820345,15.32z/data=!4m5!3m4!1s0x344cddc05d55c1bd:0xc183f9fcb18cd20!8m2!3d30.257719!4d120.78241?hl=en>

<sup>37</sup> Kang, X. (2014, February 12). Changes in Hangzhou Bay Bridge's traffic flow. *Jxxznews*. Retrieved August 16, 2016, from <http://jxxznews.zjol.com.cn/xznews/system/2014/2/12/010669.shtml>

<sup>38</sup> Shen, Q., & Chen, Q. (2016, July 19). Jiashao Bridge -- important contributor to local benefits. *GMW.cn*. Retrieved August 16, 2016, from [http://news.gmw.cn/newspaper/2016-07/19/content\\_114331690.htm](http://news.gmw.cn/newspaper/2016-07/19/content_114331690.htm)

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sectors involved in Hangzhou Bay Bridge began to divest from the existing project, and public sectors hold over 80% of total shares. In 2013, public sectors got into debt of RMB 850 million, and it was projected that the total costs (RMB 11.8 billion) would not be able to be recovered after 30 -yearfranchise period. <sup>39</sup>



Fig5. Locations of Hangzhou Bay Bridge and Jiashao Bridge

<sup>39</sup> Survey on Hangzhou Bay Bridge's Operation. (2013, September 23). Tencent News. Retrieved August 12, 2016, from <http://news.qq.com/a/20130923/001301.htm>

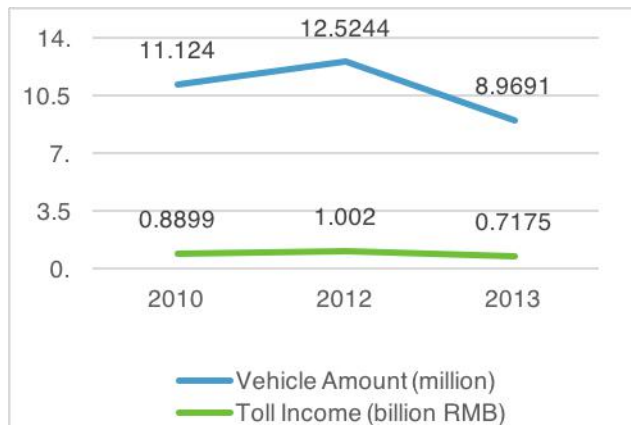


Fig.6 Traffic Flow and Toll Income of Hangzhou Bay Bridge from 2010 to 2013

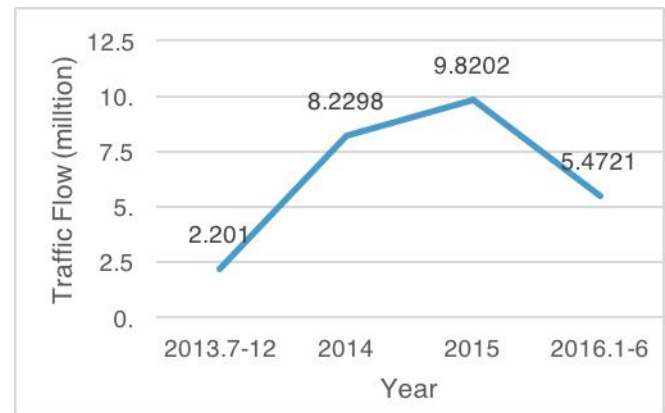


Fig.7 Traffic Flow of Jiashao Bridge from 2013 to 2016

## 6 Who Is To Blame?

To consider responsible for the project failure, it seems that public sectors were primary due to the following three faults. The biggest misstep is that governments did not obey the contract by building new across-sea bridge. This behaviour reduced private sectors' benefits directly and significantly. Also, this is the main reason that private enterprises rejected to pay for extra costs and quitted from the bridge project. The second concern is about risk transfer. Risk allocation for Hangzhou Bay Bridge project was not reasonable, since almost all of the risks were transferred to private sectors. This was extra opposite to P3 requirement for risk transfer . According to P3 Canada, the best risk allocation is '*In a P3, project risks are transferred to the party best able to manage them.*'<sup>40</sup> In this project, some sorts of risks such as economic fluctuation should be bore by public sectors, as they were able to stabilize local economy more effectively by political pathways. By contrast, private sectors were required to raise capital frequently as a result of undertaking this risk. In addition, insufficient VFM assessment contributed to the failure as well. Since there was no adequate assessment for economic

<sup>40</sup> P3 General Information. (n.d.). Retrieved July 19, 2016, from <http://www.p3canada.ca/en/about-p3s/frequently-asked-questions/>

efficiency, governments overestimated overall benefits. This was the main reason that the project could attract so many private firms to participate.

Although public sectors were the largest contributor to the failure, private sectors should be responsible for failed project. Those 17 non-government enterprises invested in Hangzhou Bay Bridge mainly due to the new concept of P3 emerging, without totally understanding real value and meaning of P3. As a result, private sectors became more passive and unclear about their responsibilities. As P3 requires, private sectors should direct the whole process of construction, while public sectors just play roles as supervisors to ensure processing well. Also, the former is in charge of reducing governments' financial pressure and risks by undertaking the majority of risks during franchise period. In this case, however, 17 non-government enterprises did not play expected roles over construction and operation period, as they did not take responsibilities of project's director and problem solving. For example, they were supposed to solve problem of capital shortage, but most of them chose to quit. Although public sectors should not always ask extra investment from private sectors when the project was faced with budget overrun, it was private sectors' duty to come up with ideal plans about addressing existing issues and controlling future cost — this was also supposed to be one of private sectors' responsibilities of risk management. Apparently, private sectors involved in the bridge did not be so sure about their normal duties, so they did not perform well. The second reason they were positive about the bridge was the estimated high return. At the beginning of construction, since they mainly focused on high ROI, they did not entirely recognize potential risks, including policy risk, currency risk, technology risk, financial risk and operational risk.<sup>41</sup> During following construction period, the occurrence of policy risk and financial risk damaged private sectors' benefit dramatically. Although governments broke the contract by approval of the project's competitor, and did not provide estimated profits, private sectors did not notice such kinds of risks in advance and make feasible strategies to avoid them. They did not ask compensation from public sectors either. On the other hand, shareholders changed very often because they chose to quit once faced with benefit loss, instead of making remedial measure. This situation made responsibility clarification harder.<sup>42</sup>

<sup>41</sup> Peng, T., & Lai, G. (2012, December 9). P3s' Risk Analysis and Countermeasures. Retrieved August 15, 2016, from [http://wenku.baidu.com/link?url=qs8JqsvTFP6tbJgU5VzfYQGnt77h7E9rHLOh-9ixbWFpSscjKNN\\_rREM4GTU8puREHeY6-8yVnwCSY3RbCT0WQDFcNbzsG5TIwfWFEaFHsm](http://wenku.baidu.com/link?url=qs8JqsvTFP6tbJgU5VzfYQGnt77h7E9rHLOh-9ixbWFpSscjKNN_rREM4GTU8puREHeY6-8yVnwCSY3RbCT0WQDFcNbzsG5TIwfWFEaFHsm)

<sup>42</sup> Yan, H., & Yan, W. (2005). Risk Management of Hangzhou Bay Bridge. *China Highway*, 13, 74-75. Retrieved August 20, 2016, from <http://d.wanfangdata.com.cn/Periodical/zgg1200513037>



In addition, there are still unpredictable and uncontrollable circumstance effecting bridge building. Cost of steel and concrete rising is typical. And environment where the bridge was build was complicated with one to the three biggest tides on Earth, the effect of typhoons and the difficult content of the sea soil.<sup>43</sup> Erosion of materials and cracking and bubbling of any concrete components became a severe issue. And toxic methane gas was discovered around 50 meters underground below the bridge location, which meant no drilling could be done before alleviating gas pressure. To solve this problem, designers and engineers used steel pipes measuring 60 cm in diameter to insert into the ground, releasing the methane 6 months in advance to drilling.<sup>44</sup> Facing with such working surroundings, labour and material costs must be higher than those of simple projects. Meanwhile, risk probabilities of any delay, damage and waste were much higher and unpredictable.

Furthermore, as I illustrated P3's development and policy framework in China in above parts, there was no relevant regulation or guidance and effective P3 system for both sectors to clarify responsibilities and find causes. So we cannot make a partial conclusion that it was governments' full fault, or private sectors deserved exiting profit loss.

## 7 Recommendations

Indeed, Hangzhou Bay Bridge failed, and it is a very typical case about how P3 was applied early in China. What can we do now are to think about why it failed and try to minimize its future loss. Meanwhile, it is necessary to give feasible options for China to use P3s better in the future.

### 7.1 How should Hangzhou Bay Bridge survive

The most important tips to minimize loss are to reduce future costs and create new changes to make money.

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<sup>43</sup> Construction Review. (2010, July 5). Retrieved July 19, 2016, from <http://main.constructionreviewonline.com/older/oct09international.html>

<sup>44</sup> World's Second-Longest Ocean Crossing Opens. (2010, July 5). Retrieved July 19, 2016, from <http://www.enr.com/>

Future costs include material cost, maintenance cost, depreciation cost and unnecessary cost like public relations cost. Firstly, new technology is required to reduce material costs by realizing higher durability and lower consumption. Then, considering desired lifespan of the bridge is 100 years, maintenance and depreciation costs cannot be ignored. The weight and numbers of vehicles have to be restricted, in order to minimize maintenance costs in terms of fixing costs, material costs and labour costs by reducing loss of depreciation. Governments should eliminate corruption, especially those among officials with high-level positions. According to a report of China's corruption, China had high level of corruption, particularly in construction industry. *"It is an open secret that 5% to 10% of total project cost has been regard as public relations fees to bribe for long time"* , *"The leaders of construction administration department and contractor-employer thing became the key part of corruption due to their higher power of contract awarding, appropriation, quality inspection and acceptance."*<sup>45</sup> Although we cannot know the exact amount of corruption for Hangzhou Bay Bridge, we have to consider its existence when we are faced with such huge-scale project between public and private sectors. Stronger supervision should be implemented to lower corruption by State-owned departments.

For making extra money to recover existing costs, it is ideal to inspire local tourism industry based on existing Haitianyizhou Sightseeing Platform. Since the main purposes for most passengers stopping at the platform are to refresh, take viewing and fill up their vehicles, more restaurants, cafes and small stores catering snakes and souvenirs could be built, while existing hotels and conference areas would be closed. Moreover, charges of Haitianyizhou Sightseeing Tower's tickets and shooting service could contribute to make profits.

It is noticeable that this project is still in franchise period, though public sectors held the majority of total shares. Governments should give rights to private participants back, and think of their considerations and advices.

## 7.2 P3 future development in China

Although the China's State Council has published P3 regulations and guidance, and introduced a quite desirable P3 application process, we have to learn from the mistakes we had made and give suggestions for better P3 application in the future.

<sup>45</sup> Xue, B. (2012, December 7). China is No.80 in global corruption index assessment with severe situation in construction industry. Retrieved August 15, 2016, from <http://www.cpmchina.com/html/2/69818.html>



### 7.2.1 Reinforcing PPP Centre's responsibilities

Although PPP Centre is regarded as the highest-level government organization with expertise on P3s, P3 projects are still delivered without unified supervision. As a result, requirements from Ministry of Finance often conflict with those from National Development and Reform Commission. This situation makes responsibility clarifying and P3 projects management more difficult.

To solve this problem, PPP Centre should be entitled more authorities to assess and manage P3 projects. Here P3 Canada is taken as a desirable example to explain what role should China's PPP Center play and how the Center works. P3 Canada provides expertise and advice in assessing and executing P3 chances at the federal level leveraging greater value for money from Government of Canada investments in provincial, territorial, municipal and First Nations infrastructure through the P3 Canada Fund.<sup>46</sup> They work with Infrastructure Canada and Building Canada Fund applicants to screen designated projects for P3 viability. Moreover, P3 Canada also requires a "Procurement Options Analysis" from projects which are found to demonstrate potential to succeed as a P3 project. What P3 Canada do could maximize value that P3s could deliver. Also, probability of failures in P3s could be minimized. *"Over the last 7 years, PPP Canada has matured into a leading source of expertise on public-private partnerships(P3s). In 2015, P3s involving over \$14 billion in capital costs reached financial close – a single-year record. Ppp Canada also had direct involvement in 5 projects with an estimated value of \$2.1 billion."*<sup>47</sup>

From long-term perspective, China's PPP Centre should still keep playing the leading role in P3 delivery with policy and financing support. But participations are also important, especially in infrastructure projects with high capital costs. PPP Centre should require project managers to do adequate assessments in order to confirm that using P3 method could generate more value than using those traditional delivery methods. In addition, those assessments could make project managers consider more possible risks by having a bigger picture. Those assessment results and considerations should be summarized and reported to PPP Centre. Then the centre should review the report and do the feasibility analysis. Projects could get to start only

<sup>46</sup> About us. (n.d.). Retrieved July 21, 2016, from <http://www.p3canada.ca/en/about-us/>

<sup>47</sup> Annual Report 2015-16: Transforming Infrastructure Delivery. (2015, December 30). Retrieved August 20, 2016, from [http://www.p3canada.ca/~media/english/annual-reports/files/2015-2016 annual report.pdf](http://www.p3canada.ca/~media/english/annual-reports/files/2015-2016%20annual%20report.pdf)

after PPP centre approves. However, it is noticeable to avoiding corruption during reviewing process. And related tools to do such assessments should be provided by the centre to applicants. The centre should also enable to require status quo at any project stages which contributes to P3s' success a lot. For example, an assessment during desifning period could help public sectors decide if P3s could deliver more value than traditional delivery methods; an assessment report for construction period is useful for both contractors to make sure all processes are run as expected; contractors could be told easily whether their project realized estiated value during operation period from an assessment. So there should not be limit on assessment times.

### 7.2.2 Promoting VFM assessment at designing stage

One of causes for failure in Hangzhou Bay Bridge is insufficient VFM assessment. As a result of this, government overestimated total potential benefits. What more important is that P3 was not evaluated as the best method to deliver the bridge. Most of countries with expertise on P3s, such as Canada, emphasize the importance of VFM assessment at designing stage. Economic Action Plan 2013<sup>48</sup> announced the implementation of a P3 screen to be applied to projects with total costs of over \$ 100 million submitted by provinces, territories and municipalities for funding under the New Building Canada Fund. All infrastructure investments creating an asset with an over 20-year lifespan and capital costs of \$ 100 million or more should be subjected to the Federal P3 Screen to determine whether a P3 approach could provide better VFM (Value for Money) than a traditional procurement method.<sup>49</sup>

China should develop a similar system to enhance VFM assessment. Under such kind of system, infrastructure projects, especially large-scaled projects with high capital costs that show preliminary P3 potential could be required to assess a range of procurement options, including a P3 method, through both quantitative and financial analysis. The major purpose for this assessment is to determine whether P3 methods could create better value than those traditional delivery methods. It should be supervised by PPP Centre, the organization which plays the dominant role in China's P3s delivery.

<sup>48</sup> New Building Canada Fund: Procurement Options Analysis Guide. (2014, March 28). Retrieved July 21, 2016, from [http://www.p3canada.ca/~media/english/resources-library/files/nbcf\\_poa\\_guide\\_20140328\\_final\\_eng\\_clean.pdf](http://www.p3canada.ca/~media/english/resources-library/files/nbcf_poa_guide_20140328_final_eng_clean.pdf)

<sup>49</sup> Federal P3 Screen: The Guide for Federal Departments and Agencies. (2016, May 9). Retrieved July 20, 2016, from [http://www.p3canada.ca/~media/english/resources-library/files/ppp\\_federal\\_p3\\_screen\\_2016\\_e4.pdf](http://www.p3canada.ca/~media/english/resources-library/files/ppp_federal_p3_screen_2016_e4.pdf)

### **7.2.3 Innovating financing system**

Considering financing methods used in previous P3 projects in China, public and private sectors relied heavily on loans from banks, especially from local banks. Although it is effective to raise desirable amount of money for construction, governments has to inspire innovation system of financing, such as attracting investment from other financial organizations like private investment company, financial intermediaries and third-party financial company. As those financial organization has much more power in money transfer, their direct participation could simplify P3s' financing process.

The primary consideration for financial organizations is public sectors' credit. Since private financial organizations look for high returns, government's credit plays the key role to analyze if the projects would succeed. Hence, only public sectors keep their credit and follow contract terms strictly, more direct capitals could be raised from financial organizations.

## 8 Conclusion

Indeed, Hangzhou Bay Bridge have not made expected profits, and is predicted that cannot recover the total capital costs at the end of 30-year franchise period. Besides unpredictable events and terrible working environment, public sectors are claimed to be in charge of its failure, because they broke the contract and damaged private sectors' benefits by introducing strong competitors. On the other hand, private enterprises did not understand the real meaning of P3s and divested halfway, which made the bridge faced with intensive financial pressure. Both of them contributed to the project failure. Now, what could they do to minimize loss are reducing unnecessary costs in the future including labour cost, material cost, maintenance cost and depreciation cost, and create potential benefits by developing tourism industry. From long-term development prospective, China's PPP Centre should be given more authorities to lead P3 development, and enforce P3 applicants doing adequate VFM assessment to determine if P3 method could create more value than traditional methods to deliver infrastructure projects. Also, new financing way is required to attract other financial organizations to participate in infrastructure delivery, instead of just heavy reliance on loans from banks.