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Success factors for financial sustainability of toll road projects: empirical evidence from China

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Abstract

Toll roads are believed to have a high ability to attract private investment since they are able to recover directly the costs of their operation and construction through toll charges. However, toll road development can only be attractive to investors and lenders if the long-term sustainability is achieved. This paper identifies and discusses various issues that government and project developers have to deal with from selected case studies. The seven selected toll road projects are priority sections of the National Trunk Highway System (NTHS) and located in strategic provinces in China. The issues examined are related to policy support, regional development, the fund-raising model, project development and the financial structure. This study reveals critical success factors to achieve sustainable toll road projects in the planning stage and to control and enhance the financial sustainability in the executing stage.

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1. Introduction

At the beginning of the 21st century, China was locked in a massive effort to rebuild and extend its transport system as a major contributing component to the overall modernization of the Chinese economy (Asian Development Bank, 1997). Chinese government viewed road development as a key component of its strategy to improve access to markets and services. The heart of the road network is National Trunk Highway System (NTHS), a network of interprovincial expressways and high-class highways of about 35.500 km, to be constructed over a 20-year period up to 2010 (Ojiro, 2003). This plan also called for strengthening access from less developed

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communities and disadvantaged areas to the economic mainstream, particularly developed coastal regions and economic centers in China.

The great investment and the long repayment period of the high-class highways have made the domestic financial resources insufficient to accomplish this enormous task. China needed to look for new and efficient ways of using both domestic and foreign capital for roads (Ping, Sanli, Talvitie, & Yufu, 1999). Since 1991, the Asian Development Bank (ADB) has provided 22 loans totaling nearly $ 3.6 billion to finance 3.000 km of highway development, in addition to 4.484 km of local roads (Ojiro, 2003). The World Bank (WB) loans have supported the financing of 1300 km of highway roads and 4000 km of other roads. The loans have played a central role in helping to solve the funding shortfall in China's road construction (Ping et al., 1999).

From 2009 there has been a trend of cancellation of private involvement in infrastructure projects in developing countries (Harris & Pratap, 2009). The global economic crises have been the main reasons for this problem, however, many other factors arose from the nature of infrastructure investment. Construction of toll road projects has many unique features, for instance, long project duration, complicated process, environmental challenges, financial intensity and dynamic organization structures (Zou, Zhang, & Wang, 2007).

From the perspective of the time horizon in infrastructure projects, during the initial period of three to five years from the start of construction, there normally exist high risks in toll road projects such as delays in construction and cost overrun. Zou et al. (2007) carried out a study in Chinese construction industry and found out that the unique risks included project funding problems, contractors' poor management ability, difficulties in reimbursement, unwillingness to buy insurance and lack of awareness of construction safety and pollution (Zou et al., 2007).

During such initial period, there generally present significant troubles of toll roads such as lower than expected traffic demand, higher than estimated operating cost which results in low profits of project. In consideration of traffic demand, Ramamurti (2003) and Richmond (1998) point out that estimates of the financial viability of projects are heavily dependent on the accuracy of traffic demand forecasts. Such forecasts are also the basis for socio-economic and environmental appraisal of transport projects. According to the experiences gained from the accuracy of demand forecasting in the transport sector, covering traffic volumes, spatial traffic distribution, and distribution between transport modes, there is evidence that demand forecasting - like cost forecasting, and despite all scientific progress in modelling - is a major source of uncertainty in the appraisal of transport projects.

All above-mentioned factors leave significant impacts on the financial sustainability of toll road projects. The study therefore aims to identify critical success factors for toll roads to achieve financial sustainability in the planning and executing stages. This can help toll road project developers to ensure that toll road projects can be more sustainable and thus more attractive to private investors.

2. Overview of projects

Chengdu - Nanchong Expressway

The Chengdu-Nanchong Expressway Project was one of the priority sections of the NTHS plan. The expressway runs from Chengdu, the capital of Sichuan Province, to Nanchong in the poorer, eastern part of the province. The project comprised civil works for construction of about 208 km of controlled access toll expressway and upgrading of approximately 300 km of provincial and county roads. Sichuan Chengnan Expressway Limited Liability Company (SCELLC) was established and responsible for the construction, operation, and management of the expressway. The company has three shareholders—Sichuan Province High-Grade Roads Construction and Development Group Co. (SPHRCD), Chengdu Jintang Transport Company, and Suining Chuanzhong High-grade Roads Limited Corporation. However, SPHRCD owns 97.5% of SCELLC's share capital.

Changyu Expressway

The project, 161km of four-lane, access-controlled toll expressway, was constructed from the provincial capital of Changchun to the Lalinhe River. The Jilin province is landlocked and forms part of the northeastern hinterland of China. The Jilin Provincial Expressway Corporation (JPEC) was established under the Jilin Provincial Communications Department and responsible for the construction, operation, and management of the expressway. JPEC initiated a revenue bond financing scheme, which raised $62 million (33 percent of total $191 million equity) from investors in China for the project construction fund through People's Bank of China.

Hunan Expressway

The Project comprised the construction of 52 km of four-lane toll expressway connecting Changsha and Xiangtan (the Changtan Expressway) and the construction of the 25 km Changsha to Yongan Class-I toll highway (the Changyong Highway). The project was constructed by the Hunan Provincial Expressway Construction and Development Corporation (HPEC) under the Hunan Provincial Communications Department (HPCD). The operation of the Changtan Expressway and the Changyong Highway were carried out by Changtan Company and Changyong Company, respectively. Changyong Company was successfully listed in the A-share section of the Hong Kong's Shenzhen Stock Exchange after being operational for two years. Since the listing, the ownership structure has changed. In 2009 HPEC owned 32.6 percent, a highway company owned 13.7 percent, HPEC's employees owned 11.6 percent, and the company which operated this project owned 42.1 percent.

Hebei Expressway

The Hebei Expressway, located in the southeast of the Hebei Province, formed part of the priority section of the NTHS from Beijing to Shanghai. The Project comprised the construction of 140 km of a four-lane, controlled-access toll expressway connecting Qingxian to Wuqiao and upgrading about 230 km of county connector roads adjoining the expressway. An International Financial Institutions Loan Project Office was set up under Hebei Provincial Communications Department and its Highway Administration Bureau, and was responsible for planning, implementing, managing, and supervising the Project. The project was run by a Project Implementation Unit (PIU) which was set up under Hebei Provincial Communications Department. The PIU also acted as liaison between Hebei Provincial Communications Department, contractors, and suppliers. After the opening of the expressway, the PIU was disbanded and staff reassigned to the International Financial Institutions Loan Project Office to handle the operation, management, and maintenance of the expressway, including other facilities of the expressway.

Xiaogan-Xiangfan Expressway Project

The Xiaogan-Xiangfan Expressway was a key element of the NTHS as part of the Shanghai-Wuhan-Xi'an-Urumqi corridor. The Project comprised construction of 243.5 km of a four-lane, controlled-access toll expressway in the western and mountainous part of Hubei and upgrading about 259 km of county connector roads. The Project Headquarter (Hubei Provincial Xiaoxiang Expressway Construction Headquarter) established within the Hubei Provincial Communications Department and a shareholding company owned by Hubei Provincial Communications Department (Hubei Provincial Xiao Xiang Expressway Company Ltd) was implementing the project.

Taihe-Ganzhou Expressway

The Taihe-Ganzhou Expressway formed a key part of the NTHS, as a section of the Beijing-Nanchang-Shenzhen corridor. The Project comprised the construction of 128 km of a four-lane, a design speed of 100 km/h, and a sub-grade width of 26 m toll expressway in Ganzhou, the second largest city in Jiangxi. The project also constructed interconnecting roads totaling 49 km and upgrading of about 180 km of county connector roads. The Project Management Office was set up under Jiangxi Provincial Communications Department and was responsible for all project stages. The Jiangxi Provincial Communications Department established the 'Ganzhou Administration Division' to be in charge of the operation, management and maintenance of the Taihe-Ganzhou Expressway.

Zhengdian – Changsha Expressway

The Zhengdian – Changsha Expressway formed a key part of the NTHS, as a section of the Wuhan-Changsha high-priority transport corridor. The project comprised the construction of 293 km of a four lane, access-controlled toll expressway with a design speed of 120 km/h. The project also upgraded about 58 km of county connector roads. For the Hubei component, People's Government of Hubei Province founded the Hubei Jingzhu expressway construction headquarters and Hubei Jingzhu expressway Chief Engineer's Office, in charge of the implementation of each component in this project. For the Hunan component, Hunan Provincial Expressway Construction and Development Corporation was responsible for the construction of the project. After the project was opened, Hunan Provincial Expressway Construction and Development Corporation established the Tucheng-Changsha Expressway Management Division to be in charge of operation, management and maintenance of the expressway.

Table 1 shows the general information of the projects.

Table 1. General information of the selected projects

Level of debt	Project name	Year of Start-Finish	New facility (km)	Upgrade (km)	Number of lanes	Total cost (USD million)	Debt/ Equity	Cost/km (USD million)
High debt	Zhengdian – Changsha Expressway Project	1999-2006	293 km	58 km	4 lanes	890.80	75/25	2.30
	Changyu Expressway Project	1999-2001	161 km	240 km	4 lanes	470.00	67/33	0.27
	Xiaogan- Xiangfan Expressway Project	2003-2007	244 km	259 km	4 lanes	862.47	67/33	2.10
Moderate debt	Chengdu–Nanchong Expressway Project	1999-2003	208 km	300 km	4 lanes	772.20	54/46	0.34
	Hunan Expressway Project	2002-2007	77 km	-	4 lanes	182.60	52/48	0.28
Low debt	Taihe-Ganzhou Expressway	2002-2006	130 km	180 km	4 lanes	371.20	42/58	2.80
	Hebei Expressway Project	1999-2003	140 km	230 km	4 lanes	479.30	35/65	2.30

3. Methodology

This research is based on secondary data from Asian Development Bank (ADB) and World Bank (WB) post-project appraisal reports, which are annually published. These reports are prepared for loan proposal, construction reimbursement and at project completion to record projects related practices, performance, and learned lessons. The results of the project appraisal are published every year and are available to the public. Individuals or organizations may consult these project records for future project planning and research.

The focus of this paper is the emerging economy of China. This country represents almost 20% of the world population (Chinese official population clock) and has been ranked the second largest economies in the world (International Monetary Fund, 2018). The construction stage of the studied toll road projects was completed between 1999 and 2003. The projects are part of the NTHS program and were designed to help eliminate road transport bottlenecks that constrained economic growth, particularly in the export-oriented manufacturing industry and agriculture.

The study has attempted to analyze the financials and costs of toll road projects in China after the construction stage and their three-to-five years of operation.

4. Analysis and results

4.1. Timely investment

4.1.1. Timely investment reflected in the attractive level of traffic demand

Demand forecasting is a major source of uncertainty and risk in the appraisal of transport infrastructure projects (Flyvbjerg, Skamris Holm, & Buhl, 2005). It is found that all selected toll road projects had to face the problem of lower than expected traffic demand. The main reason was that toll roads were not developed in accordance with the socio-economic development. This is partly due to the insufficient numbers of studies investigating the socio-economic conditions. Moreover, the economic development of regions was so low that traffic demand could not reach the planned level.

A good example can be seen in the case of Chengdu Nanchong Expressway. After this toll road was opened, the traffic volume was about 30% lower than expected in 2003 and about 20% lower in 2004. The actual traffic on Changyu Expressway was about 27.7% lower. The same problem happened to projects that were built and operated by government organizations. The actual traffic volumes on Hebei Roads Development, Hubei Xiaogan- Xiangfan Highway Project, Second Jiangxi Highway Project, National Highway Project were about 35%, 19%, 7%, 38% lower respectively. Figure 1 below shows the difference between forecast and actual traffic demand.

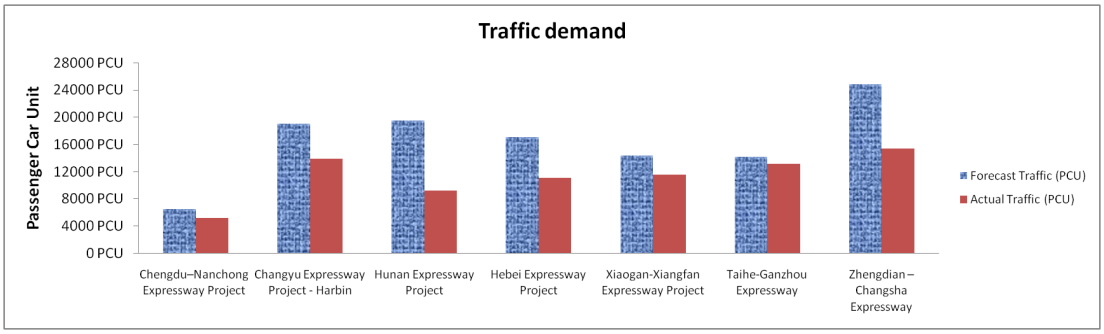

Fig.1. Difference between forecast and actual traffic demand

Additionally, traffic demand significantly influences the operating ratio which measures the amount of operating expenses versus the total amount of operating revenue, since it affects the revenue generated through the toll rate. For all toll road projects selected in this study, the expressway was constructed with four-lane width, which was suitable for the traffic flow of around 25.000PCU-50.000PCU in five to ten years after operation. In fact, it is found that the actual traffic flow of most projects was much lower than the expected volume of the designed width. The minimum planned traffic flow was only reached after about 10 to 15 years of operation. That was the reason why for some projects with two or three years delay, the operating revenue was higher than that for projects with no delays. This has an immediate impact on the operating ratio of the projects. Table 2 shows the risk assessment of the actual traffic demand and the duration before traffic flow reaches the minimum level of 25.000 PCU.

Table 2. The impact of actual traffic demand on project financial sustainability

Project name	Actual traffic demand	Duration before traffic flow reaches 25.000 PCU	Assessment for the timely investment	Risk assessment
Chengdu–Nanchong Expressway Project	5.214 PCU	19 years	Too early	Very high
Changyu Expressway Project – Harbin	13.922 PCU	7 years	Appropriate	Medium
Hunan Expressway Project	9.212 PCU	9 years	Early but needed	Medium
Hebei Expressway Project	11.078 PCU	4 years	Appropriate	Low
Xiaogan-Xiangfan Expressway Project	11.588 PCU	8 years	Early but needed	Medium
Taihe-Ganzhou Expressway	13.114 PCU	11 years	Early but needed	High
Zhengdian – Changsha Expressway	15.364 PCU	5 years	Appropriate	Low

The data shows that Chengdu–Nanchong Expressway project got a high operating ratio (102% and 118% in the first two years of operation) since the project generated low revenue. Its actual traffic demand was too low (5.214 PCU) compared with the designed traffic for four-lane expressway (25.000PCU - 50.000PCU). The traffic demand was forecasted to reach 25.000 PCU in 2022, 19 years after project operation.

By contrast, the operating ratio of Zhengdian – Changsha Expressway was much lower, decreasing from 52.7% in the first year to 32.9% in the fifth year. Right after the start of operation, the actual traffic demand was about 90% of the forecast. The demand was also estimated to reach 28.860PCU in 2010, only after 7 years of operation. This evidences that timely investment or investment at proper time ensures proper traffic flows and high project revenues. Table 3 shows the risk assessment of actual traffic demand and operating ratio.

Table 3. The impact of actual traffic demand on current operating ratio

Project name	Actual traffic demand	Current operating ratio (%)	Risk assessment
Chengdu–Nanchong Expressway Project	5.214 PCU	88.9% (High)	Very high
Changyu Expressway Project - Harbin	13.922 PCU	27.2% (Low)	Low
Hunan Expressway Project	9.212 PCU	33.1% (Medium)	Medium
Hebei Expressway Project	11.078 PCU	39.0% (Medium)	Medium
Xiaogan-Xiangfan Expressway Project	11.588 PCU	59.9% (High)	High
Taihe-Ganzhou Expressway	13.114 PCU	34.4% (Medium)	Medium
Zhengdian – Changsha Expressway	15.364 PCU	42.2% (Medium)	Medium

Low traffic demand does not only affect the financial sustainability of toll road companies in operation but also limits the attractiveness to private investors.

4.1.2. Coordinated development of toll roads, feeder roads, and industrial areas

The traffic growth rate determines the revenue of a project and hence its financial sustainability. It is obvious that the actual traffic growth rate is influenced by the upgrade of feeder roads and the development of local industrial zones along the toll road. This can be seen in the analyzed projects.

Changyu Expressway Project, for instance, was developed in coordination with the project-influenced area. The provincial government connected the project expressway with the provincial road network by link roads and interchanges (240km). As a result, the growth rate of traffic demand was high and reached 25% in the first five year.

The Xiaogan-Xiangfan Expressway was developed in combination with the construction and upgrade of 259km local road network to improve the access of low-income counties to the markets in the economic centers, leading to 20% traffic growth in the first five years.

Hebei Expressway Project got the highest traffic growth rate (39%) since local Government increased the transport of building materials, mineral ore, steel, and timber from north-eastern PRC to the central region. In addition, the local road network was either upgraded or constructed (230km) and major expressway interchanges with the surrounding network were established.

The parallel development of industrial zones contributes significantly to the increase of traffic flows. This is well illustrated in the case of Hunan Expressway: the local Government advanced the opening of three economic development zones right after the opening of the expressway and the region around the expressway became a strategic business location. As a result, a dramatic traffic growth (2%) was witnessed although no local road upgrading was included in the project.

In contrast, Chengdu–Nanchong Expressway got the lowest traffic growth rate (11%). The Nanchong province, where the project was located, has several famous tourist attractions and the economy depends mostly on tourism industry. The local Government planned to accelerate tourism-oriented development by improving the infrastructure at several major tourist attractions but failed to reach the planned growth rates. Thus, although the project included the upgrading of 300km local road, the traffic growth rate was very low. Table 4 shows the risk assessment of the impact of traffic growth rate on future revenue through current operating ratio.

Table 4. The impact of actual traffic growth on current operating ratio

Project name	Traffic growth rate (%)	Current Operating Ratio (%)	Risk assessment
Chengdu–Nanchong Expressway Project	11.0% (Low)	88.9% (High)	Very high
Changyu Expressway Project - Harbin	25.0% (High)	27.2% (Low)	Very low
Hunan Expressway Project	25.2% (High)	33.1% (Medium)	Low
Hebei Expressway Project	38.6% (Very High)	39.0% (Medium)	Low
Xiaogan-Xiangfan Expressway Project	20.3% (Medium)	59.9% (High)	Medium
Taihe-Ganzhou Expressway	23.0% (Medium)	34.4% (Medium)	Medium
Zhengdian – Changsha Expressway	19.7% (Medium)	42.2% (Medium)	Medium

4.2. Sufficient financing

4.2.1. Appropriate combination of sources of funds

There should be an appropriate relationship between the ability of generating revenue and the combination of funding sources (Tam, 1999). The appropriate debt to equity ratio helps projects gain high leverage and get private investors for equity capital (Devapriya, 2006). If projects use too much debt while the operating revenue is low, most operating revenue will be used for debt payments. Hence, the risk of losing the investment seems high. On the contrary, if a project uses too much equity while the ability to generate operating revenue is high, the leverage of debt would not be sufficiently used.

The capital of Chengdu–Nanchong Expressway Project was raised from four sources: grant (18%), ADB loan (32%), domestic loan (21%), and equity (28 percent). The D/E ratio was 60/40. In this project, high debt to equity ratio does not seem suitable since the project was constructed in an area where traffic demand was low. Hence, not enough revenue could be generated to cover the debt services, resulting in a very high operating ratio and accordingly the finance situation was unsustainable. The project, therefore, needed more support from Government to secure the financial condition and showed that the Government-Build-and-Operate model appeared more appropriate than a Public-Private-Partnership model.

On the contrary, the Zhengdian – Changsha Expressway is located in an area with a high economic growth rate generating high traffic demand. Although this project had a high D/E ratio (75/25), its financial situation was still sustainable because of the sharp increase in revenue. Besides, with high profit and high returns on equity (ROE), the project was appealing to investors from private sector. Apparently, in this case, a Public-Private-Partnership model proved to be effective in reducing the financial burden of the Government.

As for Changyu Expressway, its financial situation was unsustainable despite its low operating ratio and high traffic demand. One possible reason was that the project owner used 50% of the revenue to invest in local construction projects, so the cash available was low. In addition, the project had a high D/E ratio (66/34). Table 5 presents the risk assessment of the toll road project considering actual traffic demand and D/E ratio.

Table 5. The impact D/E ratio on financial sustainability

Project name	Actual traffic demand	D/E ratio	Debt coverage ratio (= Net operating income/Total Debt service)	Risk assessment
Chengdu–Nanchong Expressway Project	5.214 PCU	54/46	0.62	Very high
Changyu Expressway Project - Harbin	13.922 PCU	67/33	1.34	High
Hunan Expressway Project	9.212 PCU	52/48	1.00	Medium
Hebei Expressway Project	11.078 PCU	35/65	0.72	Medium
Xiaogan-Xiangfan Expressway Project	11.588 PCU	67/33	1.15	Medium
Taihe-Ganzhou Expressway	13.114 PCU	42/58	3.51	Low (project should use higher D/E ratio to get higher financial leverage)
Zhengdian – Changsha Expressway	15.364 PCU	75/25	3.72	Low

4.2.2. Good preparation for cost over-run with emergency budget

Cost overrun negatively affects financial sustainability. To cover the cost overrun, project owners mainly find three different sources of fund, namely short-term loan from domestic banks, central or local government budgets and contingency budgets.

a. Short term loan

Short term loans are often used in joint venture projects, where project owners cannot receive more funding from central or local government. Using short term loan as emergency budget to cover construction cost overrun is highly risky since the project owner has to pay higher interest rates and debt service fees. Projects with short term loans may encounter more problems if there is low traffic demand, low traffic growth rate, inappropriate toll rate structure

or higher operating cost. An example is the Chengdu–Nanchong Expressway Project with a low current ratio (0.84). Its total investment costs were overrun (by 33.34%), especially in civil work and land acquisition, and the project owners used huge short-term loans to cover this (106 million USD, 14.4% of total cost). As a result, its current liabilities increased sharply.

b. Local government subsidizes

Another solution to cost overrun is to seek additional funding from local government. This source of funding is safer than short-term loan because there will be no increase in current liabilities and debt ration accordingly. However, this source of fund depends significantly on the financial capacity of local governments. If the amount of cost overrun is too high, the financial burden to local governments will be heavier, which explains why local government only subsidize projects they own if there is no other way of financing. Xiaogan-Xiangfan Expressway Project, for example, had a high cost overrun (31.52%), mainly due to civil work, whereas its current ratio was quite high (3.14). The project, nevertheless, did not use short-term loans; instead, the local government used their own budget to fulfill the over-budget. Table 6 assesses the risk considering cost overrun, current ratio and the source of fund that was used to cover the overrun.

Table 6. The impact of cost overrun and sources of contingency budget to financial sustainability

Project name	Cost overrun/Cost Underrun	Current Ratio (Current Assets/Current Liabilities)	D/E ratio	Source of fund to cover cost overrun	Risk assessment
Chengdu–Nanchong Expressway Project	33.34%	0.84 (Low)	54/46	Project owner (through short term loan of domestic bank)	High
Changyu Expressway Project - Harbin	-2.45%	0.34 (Low)	67/33		Very high (because project owner used 50% revenue to invest to local construction project, therefore the available cash was low, high debt service due to high D/E=66/34, additionally high percentage of domestic bank with higher interest rate.
Hunan Expressway Project	-9.51%	7.97 (High)	52/48		Low
Hebei Expressway Project	1.33%	17.00 (High)	35/65	Local government (government budget)	Low
Xiaogan-Xiangfan Expressway Project	31.52%	3.14 (Medium)	67/33	Local government (government budget)	Medium
Taihe-Ganzhou Expressway	-19.75%	15.49 (High)	42/58		Low
Zhengdian – Changsha Expressway	-6.43%	16.90 (High)	75/25		Low

c. High contingency budget

In some cases, a contingency budget is prepared in advance for the possibility that some future uncertainties will not be successfully managed (Ramamurti, 2003).

However, to establish an appropriate amount of contingency budget that could cover all the risks is still a difficult problem for project developers. Contingency budgets for toll road projects depend on the length of the route, the geological condition, the socio-economic development, the ability of the project implementation agency, and engineering contractors.

It could be seen in the analysis that contingency budgets vary from project to project and from area to area. Government-owned projects had higher contingency budgets than other projects. For instance, Zhengdian – Changsha Expressway had around 20% contingencies budget. Projects with participation of the private sectors got lower contingency budgets, so they were able to reduce the total investments. Contingency budgets played a

significant role in reducing financial risk. Table 7 evaluates the risk considering cost overrun, contingency budget and current ratio.

Table 7. The impact of investment cost overrun and contingency budget on current ratio

Project name	Cost overrun/(-) Underrun (without contingencies)	Contingency (%)	Current Ratio (=Current Assets/Current Liabilities)	Risk assessment
Chengdu–Nanchong Expressway Project	33.34%	12.60%	0.84	
Changyu Expressway Project – Harbin	-2.45%	10.84%	0.34	
Hunan Expressway Project	-9.51%	18.29%	7.97	Low (project got total cost underrun although there was budget overrun of land acquisition (65.91%), interest during construction (74.4%) and civil works (1.9%) since it used high contingencies budget (18.29% of total investment cost)
Hebei Expressway Project	1.33%	10.04%	17.00	
Xiaogan-Xiangfan Expressway Project	31.52%	8.06%	3.14	
Taihe-Ganzhou Expressway	-19.75%	12.95%	15.49	
Zhengdian – Changsha Expressway	-6.43%	19.80%	16.90	Low (because project used very high percentage of contingencies budget, hence total project got underrun)

4.3. Land acquisition and resettlement

Land acquisition activities are a critical problem causing project delay and construction cost overrun of toll roads in China (Zou et al., 2007).

Among seven projects selected for this study, Chengdu–Nanchong Expressway Project had the highest cost overrun of 172.67% in land acquisition and Changyu Expressway Project had the highest cost under-run of -61.04%. On average, the cost of land acquisition and resettlement increased by 23.67%. Figure 2 below presents the difference between estimated and actual cost of land acquisition.

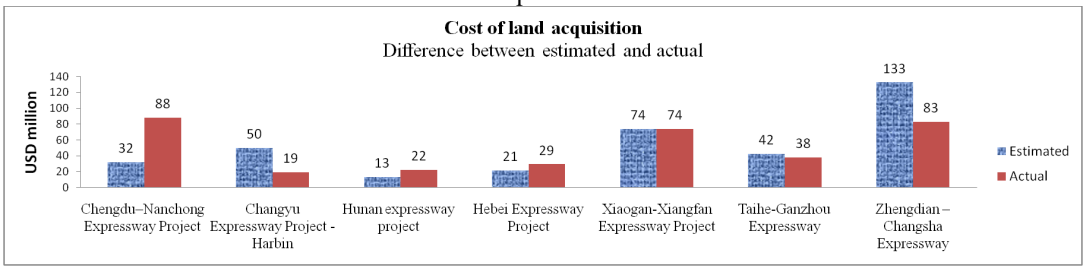

Fig.2. Difference between estimated and actual cost of land acquisition

The investigation showed that the Resettlement Plans prepared by international consultants provided the basis for the resettlement implementation, monitoring, and evaluation of all seven projects. The acquisition areas in the Resettlement Plans were estimated based on the feasibility study, while the actual areas were based on the detailed design. This difference caused an increase by 173% in land acquisition cost in the Chengdu – Nanchong Expressway Project.

Another reason for this increase was the adjustment of compensation rate. As of January 1st, 1999, China implemented the amended Land Administration Law. This amended law required higher compensation standards for land acquisition compared with the old law. The law stipulated that the compensation and the resettlement subsidy

for cultivated land would be 6–10 times and 4–6 times of the average annual production value per mu† during the previous 3 years. The corresponding rates in the old law were 3–6 times and 2–3 times.

Furthermore, the compensation scheme for temporary land occupation also contributed to the budget overrun. Compensation for temporary land acquired for the project was paid directly to the affected households by civil contractors. The cost of temporary land occupation varied. The amount of land to be acquired temporarily was not well estimated before construction since contractors were responsible for this. In Southern Yunnan Road Development Project, for instance, the amount of temporary land acquisition increased from 50 ha to 564 ha and the area of buildings demolished also increased by 40%, from 50,429 square meters to 70,825 square meters.

Additionally, the Yunnan provincial government approved a policy that local governments pay the compensation first, then project is getting reimbursed by Expressway Company after its operation. Subsequently, each county formulated its own set of standards and procedures for compensation based on the provincial standards and the agreed budget. Resettlement costs doubled from $22 million to $44 million because of the increased scope of impacts, new administration fees, modifications of alignment and service areas, and land needed for landslide control. Actual cost might further increase due to pending claims for farmland degradation. Resettlement funds were financed by local governments although they did not have enough fiscal ability to do so. As a result, the land acquisition activities were delayed for two years.

In conclusion, inadequate resettlement plans and unclear compensation standard for land acquisition and house reallocation were the main reasons for the increase in land cost of toll roads.

4.4. Appropriate toll rate structure

The toll rate has a significant impact on toll road revenue since toll charges are the main source of revenue (Yang & Lee, 2008). Tolls can be used to recover debt and operating expenses. The toll rate structures of Chengdu–Nanchong Expressway and Hunan Expressway were set at lower rates than other projects (0.32 and 0.35 CNY per vehicle-km respectively); hence, the operating ratio was higher since there was not enough revenue generated through toll.

Furthermore, the volume of traffic on the project expressway depends upon the toll charged. The proportion of vehicles that will transfer from the existing network to the new expressway depends upon the total cost of travel perceived by users and the savings expected from using the expressway. For the seven case studies investigated, toll rate was planned to increase by 10% to 15% every five years in current terms to offset the impact of domestic inflation. However, Provincial Department of Communication was unable to adopt a firm policy on future toll adjustments that would allow the developer to predict future revenues with confidence.

Moreover, the toll rate for large truck is assumed to remain at the current level for at least three to seven years. Most concession agreements regarding this matter are vague, mainly specifying that toll adjustments will adhere to provincial policies. Thus, investors have no option but to prepare for an additional risk premium. This additional cost would be lower if the concession agreement clarified how future toll increases would be handled (e.g. by specifying a fixed adjustment frequency and indexing the tolls to an independent standard of cost inflation). Table 8 shows the toll rate level for car and small truck of each case study.

Table 8. Toll rate level for car and small truck of each case study

Project name		Chengdu–Nanchong Expressway Project	Changyu Expressway Project - Harbin	Hunan Expressway Project	Hebei Expressway Project	Xiaogan-Xiangfan Expressway Project	Taihe-Ganzhou Expressway	Zhengdian – Changsha Expressway
Toll Rate (for cars and small trucks)	Actual	0.32	0.40	0.35	0.40	0.40	0.40	0.40
Period to increase	year	5 years	5 years	5 years	5 years	5 years	5 years	5 years

† mu is a Chinese unit of area, equivalent to 667 square meters

4.5. Restriction of truck overloading

Truck overloading was a problem throughout China. It was found that over 75% of trucks were overloaded with the average overload sometimes exceeding 100% (Yang & Lee, 2008). A few years after opening, the right-hand lane of many expressways already showed signs of damages due to the high number of overloaded trucks.

In Changyu Expressway Project, the excess of weight over the allowed maximum ranged from 18 to 27 tons per truck (equivalent to 3.6–4.5 tons of excess weight per axle.) The problem was rooted in the transformation of the formerly state-owned transport sector into a private one, an environment with higher competitive pressure. This pressure caused truck operators to manipulate axles, overload their vehicles, or maximize operating hours to increase the payload. These factors did not only contribute to accidents but also had a negative impact on the economic life of the pavement and thus the sustainability of the expressway.

However, truck overloading was a national problem which cannot be addressed separately by each province. The expressway companies had no right to force overloaded trucks to stop and unload. The police did this for grossly overloaded trucks, which they spotted while on patrol and diverted to a weighing station. However, these stations were too few to have a significant impact. They were also too small to impound more than a fraction of the culprits. Some provinces, including Jiangxi, had started charging overloaded trucks higher tolls, but even a doubling or tripling of the toll rate did not come near matching the amount of damage done to the road by the extra heavy vehicle, since damage increased with the fourth power of the axle load.

To keep transport costs low, the Government has been reluctant to take strong measures to enforce legal axle loads. The current measures, including spot checking and fining by the police, and higher tolls based on weigh, seem to do little to persuade truckers to reduce overloading. Another solution, which might not have been considered sufficiently, would be to increase the design axle load. Designing stronger pavements, while costly initially, may lower the total cost of transport by allowing heavier trucks. Higher permissible axle loads may also make enforcement more acceptable to the transporters. Axle loads were increased in the European Union after studies showed that they would result in lower overall transport costs, including infrastructure and vehicle operating costs. Table 9 explains the problem of truck overloading of each project and their solutions.

Table 9. The problem of truck overloading and solutions to each project

Project name	Truck overloading occurred	Solution to solve problem
Chengdu–Nanchong Expressway Project	Yes	Yes, a mobile weighing machine was in place at the Chengdu toll gate and is used for random weighing of heavy trucks.
Changyu Expressway Project – Harbin	Yes	No
Hunan Expressway Project	Yes	Yes, vehicle weigh-in-motion detectors were installed to detect overloaded trucks. However, the equipment was only installed at the northern entrance to the expressway on the Tianjin- Hebei border and at the southern entrance to the Hebei-Shandong border. By the end of 2006, weigh-in-motion stations will have been permanently installed along the expressway at all entry and exit points.
Hebei Expressway Project	Yes. Owing to the absence of weighbridges installed on the expressway, information on the level of truck loading had to be collected by visual assessment, supplemented by interviews with traffic engineers. It was found that more than 30 percent of the trucks (light, medium-size, and large) are routinely overloaded, and that the overload could reach 40 percent of the respective trucks' capacity.	No
Xiaogan-Xiangfan Expressway Project	Yes	Yes, by enhancing enforcement overloading of trucks was reduced from 90% to 15%.
Taihe-Ganzhou Expressway	Yes	No

Zhengdian – Changsha Expressway	Yes	Not yet, but Hunan Government decided to implement toll surcharge policy (levying higher tolls on overloaded trucks) from October 2006.

5. Conclusions

This paper describes a comprehensive examination of seven toll road projects in China. The planning and operating of the seven toll road projects reveal various aspects of projects' financial sustainability, such as land acquisition, revenue generation, penalty for truck overloading, timely investment and some financial risk absorbing strategies. The study suggests five success factors be considered when developing toll road projects. First, government must ensure effective land acquisition and resettlement to reduce the risks of delay and cost overrun. Second, government should provide a proper toll rate structure and fix frequency of tolling adjustment to ensure the certainty of revenue stream and help toll road developers to foresee their profit. Third, strict penalties for truck overloading should be established to reduce the maintenance cost. Fourth, project developers need to select the time of investment carefully. An appropriate time of investment based on socio-economic situation ensures proper traffic demand. Fifth, project developers should use appropriate combination of sources of fund, corresponding to the ability to generate revenue of project; additionally, they should have good preparation for cost overrun by building up emergency budgets. Such outcomes might beneficial for local Government, authorities and project owners in developing counties to successfully develop toll road projects under various uncertainties.

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