

# Compositional Stochastic Model Checking Probabilistic Automata via Assume-guarantee Reasoning

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## ABSTRACT

Under the environment of globalization, the international construction projects are implemented more and more frequently and the risks the international construction companies may take are various as the Chinese “One Belt, one Road” strategy expands more deeply. Therefore, this study aims to analyze what kind of risks may show up and discuss the methods to prevent and tackle with risks by studying two cases on the area of international Hydropower projects in Turkey and Laos, respectively. From reviewing the previous research and by comparing the Biregik Dam in turkey with the Theun Hinboun Hydropower Project in Laos, this study concludes that the risks from the several aspects should be buffered by using the corresponding strategies.

**Keywords:** Risk management, Hydropower project, International construction, Case study.

## 1. INTRODUCTION

Under the circumstance of the global economy recovery and the tendency of globalization, China initiated the strategy “One Belt, One Road” to cooperate with the surrounding countries around the “Road” to develop the economy through various aspects. The strategy inherits the long-term cooperation in culture, commerce and trade on history, and also adds new meaning of this road. Moreover, due to the historical strategies of development, China urgently needs to enlarge the inland marketplace to balance the development gap between western cities and eastern cities of China. In addition, after the economic crisis, China has grown rapidly and currently is the second largest economy around the world. Therefore, it is necessary to construct the international economic order that is beneficial to China and “One Belt, One Road” strategy is indispensable to boost external demand by expanding external markets.

The strategy “One Belt, One Road” (B&R) covers three continents, including Asia, Europe and Africa and 65 countries with five separated lines and consists of six economy corridor. There are three lines on the land and two go across the ocean. Firstly, for the “One Belt” the two lines in the ocean, it starts from the South China sea and spreads to Europe and passes the Indian Ocean and

the South Pacific Ocean. The countries in Asian of this line are typically developing countries and need the support from the developed countries like Thailand, India, Malaysia, etc. However, \fixed by the strategy, the assistance of highly developed countries in Europe such as Poland, Russia are available. In addition, those developed countries benefit from it as well on some aspects like the natural resources and sufficient labors. Secondly, for three lines in lands, they are based on the central cities along the line and go through the Asia to Europe. This research focuses on the Middle East and Southeast Asia. Therefore, the features of countries in the area will be demonstrated as follows. There are 16 countries in the Middle East participating the strategy. From the perspective of resource, the Persian Gulf is one of the seven major oil storage areas. Besides, the Middle East has long been the transportation junction between east and west since the ancient times, which gives the experience to cooperate again. Eleven countries in the Southeast Asia take part in the “B&R”. And almost the economy of every country dramatically increase. And the local manufacturing industry is relatively developed. For example, the manufacturing industry in Indonesia, Philippines, Vietnam and Thailand is concentrated in tailoring and agricultural product processing. Instead, like Singapore and Malaysia, they are focus on Electronic manufacturing.

In summary, the countries in Southeast Asia have similar economic structure to China and complementary resources. Frankly speaking, this strategy effectively utilizes the advantages of each country to create better opportunities for international cooperation.

For achieving the goals of “B&R” early, international construction projects play a necessary role in the strategy. During the deep adjustment of the financial crisis, increasing number of countries in Middle East have less capacity of increasing construction investment. From the international perspective, it does help the cooperating countries’ local governments improve their construction and recover their economy. For China, it provides more chances for its companies to develop their skills and cultivate more talents focused on the international negotiation. Therefore, “B&R” is a strategy that is necessary to be implemented under the circumstance of the global economy. In addition, under the influence of the international economic situation, Chinese international construction companies (CICCs) [4] also face lots of challenges in environment and professional work. Various difficulties happen to Chinese overseas projects from various aspects, including policy, society, finance, and the abilities of cooperating enterprises. Therefore, this study aims to investigate the risk management for international hydropower projects in Turkey and Laos.

The remainder of this study is organized as follows. Section 2 reviews the existing literature on the critical successful factors and risk management of international projects. Section 3 illustrates two cases associated with hydropower projects. Section 4 discusses the causes of conflicts and risks. Section 5 provides conclusions and discusses limitations.

## 2. LITERATURE REVIEW

Existing studies have suggested that there are five necessary factors resulting in the success of international construction enterprises. Liu and Rowlinson [4] (2013) pointed out that the procurement innovation was able to enhance competitive advantages and provide more valuable contribution to the society potentially by the analysis of the successful measurement the CICCs [4] made for participating the international markets. Under the environment of the globalization, from Lu et al. (2013), the competition methods have changed gradually from the traditional bidding method into the competition of the procurement innovation (including Build-Operate-Transfer mode (BOT), Public-Private Partnership (PPP) and Private Finance Initiative (PFI)) which has the ability of attracting bigger and more suitable market. In addition, it has been put forward by the Corkin, L[1] and March (2012) that the local linkages development which is the strategy of the large Chinese companies state-owned enterprises (SOEs) is a determinant which explains why

the reestablishment projects in Angola succeeded. Additionally, referring to Deng et al. [2] (2014), whether the international political environment is peaceful with little threats or not and the ability of the international construction enterprises tackling with the threats are a vital factor affecting whether the international construction enterprises have a higher possibility to succeed. According to Deng et al. [2] (2014), the definition of the project system vulnerability was put forward and the idea that incorporating the analysis of the vulnerability into risk analysis was able to help the international construction enterprises to manage the risks. It was proposed that there are some critical success factors leading to the success of the enterprise risk management (ERM) and they include three most important factors, including commitment of the board and senior management, risk identification, analysis and response and objective setting. In addition, the relationships between them affect the success of ERM as well, such as 1) execution and integration; 2) communication and understanding; and (3) commitment and involvement of the top management [5] (Zhao et al., 2013).

Although there are various studies aiming at the improvement of risk management for international construction projects, few of them are based on the local projects which fail in foreign countries. Therefore, this research aims to use two cases associated with hydropower projects to enhance the understanding on risk management for international projects.

## 3. CASE STUDY

### 3.1. The Biregik Dam

- The Biregik Dam, located in Turkey, is a part of Anatolia project to use the power and potential nutrition of the Euphrates rivers to irrigate the plains. The dam and its hydropower project is the first large-scale Build-Operate-Transfer (BOT) project which is able to generate 2.5 billion KWH annually.[3] And the aim of this project is to bring the support in economy and society to one of the least developed areas in Turkey. The contract was signed at November of 1995 and the operation period lasts 15 years (from 2001 to 2016). And it was constructed by the union of Turkish enterprises and foreign companies. [3] The construction period started in 1996 and finished in November 1999. When the operation period finished, its right of management was transferred to the department of Energy and Natural Resources of Turkish government for free. The total investment of this project is 1.566 billion dollars, consisting of 18% equity capital (0.284 billion \$) and 82% debt capital ( 1.282 billion \$). [3] Its debt capital is totally provided by the commercial banks without the bilateral and multilateral development banks. The length of maturity of the part of debts which

have guarantee is 15.5 years, and for those without guarantee are 8 years. [3]

- In terms of the GAP mentioned above, it is a big-scale public project focused on using two rivers' energy to produce the electricity and fertilize the plains between two rivers. While the construction was finished in 2010, the whole project produced the electricity that equals to the entire national energy consumption in 1988. [3]

- However, there existed a controversy about the contingency questions, such as the flood that submerging plenty of fields, the erosion of river bed, the deforestation, and loss of many species. In addition, approximately 6500 local residents required being relocated, since 44 villages were submerged by floodwater. Nevertheless, the low compensation, which is not even able to let villagers afford the expenses of rebuilding houses, caused the protest from the locals. Unfortunately, we are not able to learn the government's following measure, as it has not been clearly announced to the public. But we do can learn lessons and risks for investing and operating international hydropower project from this case study.

### ***3.2.The Theun Hinboun Hydropower Project***

- The Theun Hinboun Hydropower Project (THHP) is the first dam with the height of 25 meters in a main tributary (Nam Theun river) of the Mekong river. It started the operation in April,1998 and it is able to generate the electricity with the power of 210MW annually. [3] However, almost 95% of generated energy is exported to Thailand and the remains are used as the expenses of domestic industry. In addition, the concession agreement with the 30-year concession period was signed in 1993. And the construction began in 1994 and it lasted for 4 years. [3]

- As for its financing structure, it is a project that has the time-limit BOT mode. [1] The operating right was licensed to the Theun Hinboun Power Company for 30 years. The 60% of the project is owned by the Laotian government and the rest of THHP is grabbed by the foreign enterprises. And most of the Lao PDR Government' s equity (US\$60 million) is lent by the Asian Development Bank(ADB). [3]

- However, there still existed some controversies including faulty process, lack of coordinated measures, and the influence on the locals. The faulty process happens because its construction started at 1994 but in May 1996 the feasibility report of this project was finished. Additionally, at the beginning of this project, the suitable communication and discussion with the local resident were not implemented. Consequently, 50 villages and about 5000 villagers are severely affected by the dam, including the decreasing of fish catches, the difficulties of traffic, the flooded farmland and the

erosion of river bed .etc. After the assessment reports were published by the institutions and individuals in succession in 1998, the villagers requested \$3.6 million as the compensation for the severe impact to them. ADB believed that it would hurt the interest of the foreign credit sides and investors if the compensation was paid by ADB. And the Lao government was asked to pay this compensation.

- Frankly speaking, the solution seemed to be unacceptable. The Lao government took the suggestion on laws and signed agreement that is decreasing the compensation into \$1 million at 1994. At October 1996, a supplemental agreement was signed between the involved enterprises and the Lao government to increase the compensation to \$2.59 million. Besides, the enterprises agreed to increase the river flow of the downstream and be responsible for cleaning the sediment of the river. Unexpectedly, there were only \$50000 used to resettling and compensating the influenced residents.

## **4. DISCUSSION**

Although the two cases both did not succeed, the features of two projects were different to some extent. Two construction projects both were BOT projects which were aimed to generate the electricity and benefit the public. Nonetheless, a huge difference existed in the investment of two projects since projects' scales were different. In addition, the financing structure of the project in Turkey was different from that in Laos including the equity capital and the source of the investment. For the former (Biregik Dam), because the situations of the foreign direct investment into Turkey occurred more frequently, small part of financing was offered by the construction company of Turkey, and the rest was lent by the commercial banks in the form of loans. The latter one (THHP) had more complex structure of investment, the equity were divided to three parts according to the scale of investment so that 60% was occupied by the Laos government (loan offered by the ADB) and the rest was divided to foreign capital in average.

For the contingency problems, the controversies about the farming field under the flood and the erosion of river bed were same. In the Turkey, more than 99% of the public believe in Christianity which claims that the human beings should be always the companion of the nature, so that the controversy about the destruction to the nature was a hardship. However, in the projects of Turkey, the resettlement of the local also became a difficult part. Whereas, there are more problems in THHP except for the irregular process also existing the controversies about the difficulties in transportation, reduce of the fishing and insufficient compensation to the local residents. The problems that must be considered includes the transportation difficulties and

the reducing in fishing, since the economy of the Laos is basically relied on the agriculture.

Therefore, the risks that the CICC's [4] face when they come into the markets of the countries of Middle East and the countries of Southeast Asia are full of the process of marching into the new markets. The biggest risk comes from the unstable and dangerous state of the politics in the middle east which produced in the wars between the Israel and the United Arab Emirates (UAE). From the perspective of the economy, the structure of the economy in Turkey focuses on the low-end manufacturing industry which leads that the CICC's have to face the competition with the local construction companies, and it might give more pressure to the CICC's. As for the countries in Southeast, taking Laos as an example, even though the government was working on the transformation from the natural economy into the commodity economy, the percentage of the agriculture keeps beyond 50% so that it might cause the decrease of the future interests of CICC's. Considering the educational level of the labors, the entire level of Middle East is higher than the Southeast Asia. Therefore, the difficulties of marching into Middle East are fewer than the Southeast Asia since there are more available labors in the Middle East. The foreign exchange risks are also necessary to be considered, the output of inflation of US dollars may cause the decrease of the exchange of the local currency so that the interests of CICC's drop.

## 5. CONCLUSION

By taking advantage of the case study of two examples in Turkey and Laos, it can be concluded from the controversies that the related parties must consider various risks during the implementation of international construction projects, such as the environmental issues, the problems about coordinating the locals with the side of construction. As for the rest risks, even though they basically vary, they are in the domain of the religions, policy, the economic situation of the nations, and even the education level. Therefore, according to the findings of this study, it is necessary for the governments to enhance the education levels of labor, reduce the conflicts with neighboring countries and publish more policies which are beneficial to the public. In terms of the international construction companies, what is vital is that by considering more about the environment, they should focus on the improvement of the technique and show more responsibilities to the projects.

There are surely some limitations of this study. Due to the lack of the international cases, this study only discusses hydropower projects. Whereas, it is needed to provide more comprehensive cases in the further researches and get more comprehensive conclusions.

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