

The Development of Sustainable Highway Infrastructure in the Strategy of One Belt and One road

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Abstract—Build a green infrastructure helps not only with the ‘One belt, one road’ strategy implementation, also supports to establish the ecological civilization and promote national development. This paper analyses the characteristic and the impacts of highway infrastructure to define the sustainable development issues in the highway. It ended up suggesting the significance of sustainable highway infrastructure in the “One belt, one road” strategy.

Keywords—Highway Infrastructure, Sustainability, One belt and one road

I. INTRODUCTION

In 2013, Chinese government launched the “One belt, one road” development strategy, it focuses to link China with Europe and Southeast Asian countries. As the main basis of strategy, the Chinese government is continually put investment in highway infrastructure. In 2015, China built 11,050 kilometres (6,870 mi), and according to the 2016 development planning, the development of the highway infrastructure will be continued [10]. However, the economic effects of highway infrastructure remain a matter of debate in the world. Due to the obvious contribution on the economic growth and social convenience is obvious, the negative impacts have been tolerated in some place. At this moment, more and more people are considering the cost of the highway on the environmental and social development. Meanwhile, the terms of sustainability and green-road have been widely promoted in the highway infrastructure development process. The relationship between sustainable infrastructure and the “One belt, one road” has become clear, since the significance of economic and strong effects on natural environment from infrastructure have been attached great importance in China. Thus, the infrastructure construction makes great contribution to national economic development and support the “One belt, one road” strategy while the depletion of non-renewable resources and environment problems has become more prominent. Under this condition, how to develop a sustainable construction is a serious question to be answered [1].

II. CHARACTERISTICS AND IMPACTS OF HIGHWAY INFRASTRUCTURE

The highway infrastructure influence people’s modern life and society progress and share the characteristics with other infrastructures: capital intensity, asset durability, government or public organisations controlled regulation concentrated, interdependent between the transportation components and resistance to change, and environmental impacts [9]. The development of highway infrastructure requires the specific conditions as construction materials, equipment, funding and building methods, types of designers, builders, and owners, which involved in a wide range of stakeholders, therefore, complexity and specialization are the obvious attribute of the highway infrastructure [7] with a large-scale, long duration and intensive capital inputs, lacking cash or liquid assets and difficult to value.

Road transportation accounts for 76% of freight movement in China with 33.43 billion metric tons in 2015, and highway transportation is covered 40.79% of the road transportation freight movement [10].

As the major public facilities, the infrastructure projects are regarded as the typical public goods and public service properties, which directly serve people’s production and living, playing a support role on economic development, guide the productivity layout, and promote urban and rural communication, safeguard the national security and social stability. Therefore, infrastructure development will help the build the great international passage, and promote the development of international economic cooperation corridor.

On the other hand, there is a growing awareness of highway projects development has impacts on the environment: gas emissions, air quality, noise pollution, landscape, biodiversity and ecosystems, soil wasters and etc [11]. For example, the large-scale characteristics of highway project can raise risk as displaced communities and livelihoods, land grabbing and local cultural devastation [5]. A highway projects development process include the activities: site preparation, earthmoving, hauling of material, paving of roadway surfaces, building of structure, and the application of architectural coatings. Some projects many also entail the demolitions of

buildings prior to site preparation. These activities have the potential to produce environmental pollutions, such as noise and emissions of greenhouse gas and air pollutants of CO₂, CO, NO_x, HC, SO₂ and PM et al. as well as noise. Demich (2009) stated that for the benefit of future it is better to start build the highway in a sustainability way, reduce the negative impacts, while not eliminate the demand of the new highway and road improvements [4].

III. DEVELOPMENT OF SUSTAINABLE CONSTRUCTION CONCEPT

With the improvement of sustainable development, the importance of the relations between environment and constructions has already prominently reflected.

In 1930s, the American Architect Fuller proposed in the construction process should concern the problems that how to assemble the human development objectives, demands, global recourses and technologies. Using the dwindling resources to meet the growing demand, and finally realize the principles of 'more with less' [12]. In 1960s, Paolo Soleri combined 'ecology' and 'architecture' to a new concept 'arology', which 'is capable of demonstrating positive response to the many problems of urban civilization, population, pollution, energy and natural resource depletion, food scarcity and quality of life.' [13]. These ideas introduced the relationship between construction and environment in substance, gave the early theories about sustainable construction.

1970s, an increasing number of people initially realized that sacrificed environment to achieve rapid economic growth is an unsustainable, and the idea of sustainability also generated. For the huge resources and energy consumption industry, sustainability in construction has been emphasized.

Along with the development of the concepts of sustainable development and sustainability, and a series of documents formulated the sustainable development strategies, such as 'Rio Declaration' and 'Agenda 21'. Since that, sustainability has become a common awareness and accepted development choice. Under guidance of the sustainability principles, the architects the 3R's building designing principles: reduce the environmental effects through recycling and reusing the materials during in building construction, demolition or renovation process [14]. By avoiding squandering resources and materials according to the 3R's principle, finally align the ideas of green constructions and sustainability. The interpretations of this principles also demonstrated that the increasing environmental awareness of the underlying dangers brought by the construction.

With the increased attention to impacts of construction, the first international conference about sustainable construction was held in Tampa, Florida, USA, 1994. During in the conference, Kibert clearly defined the term of sustainable construction, and applied the sustainability principles into the construction process – planning, design, operation, renovation, and deconstruction phases [8]. It evolves the concept for applying sustainability in construction from the perspectives of project life cycle. In view of this situation, construction needs to be conformed to the sustainable development, and put much effort on achieving maximal effective utilization of non-renewable resource, and pollution reduction.

During in this period of time, the concepts of sustainable construction achieve the progression, in October 1998, in Canada held the international conference called Green Building Challenge. During in the meeting a framework called GBTool for assessing the energy and environmental performance of buildings was developed (International Initiative for a Sustainable Built Environment, 1998). This conference disseminates the idea of sustainable building by the framework of GBTool to provide a system of assessment

criteria for buildings. The progression indicates that the impacts of construction already been widely recognized, in 2000, the International Conference on Sustainable Building (GBC, 2000) held in Maastricht, Netherlands, the progress in green building design in global was demonstrate, and examine the building environmental assessment [3]. Afterwards, in 2002, the world congress of Sustainable Building (SB'02) was held in Norway. In 2005, the World Sustainable Building Conference (SB'05) held in Japan (EU-Japan Centre, 2015). The concept has been moved forward and made tangible progress in these conferences, to pave a surer path for improving the sustainable construction. At present, the law-making in green building right in global countries has become a trend. The studies in the world are exploring the methods and approaches to realize the sustainable construction to maximally save the resources and energy, preserve the ecological environment, satisfy the needs of people and provide the healthy and comfortable living conditions.

The studies on reducing the influence of natural environment and the public living have a growing emphasis. Thus it can be seen that, with the deepening of social sustainable development sustainable construction has been an increasing attention, it already been a development and transformative trend for construction and construction engineering. In this case, many people and organisations have given the definitions of sustainable construction. The classic definition of sustainable construction is from Kibert (2006) "Creating and operating a healthy built environment based on resource efficiency and ecological design [8]."

The Development of sustainable construction shows the changes of sustainable construction concept as following: Firstly, the concept has been expended over the initial meaning of environmental protection and energy saving. It not only concerns the influence of the nature in the process of construction, also begin to focus on the influences of the social and individual quality of life, and pay close attend to health safety of the practitioners. Further, the concept has been expended over the initial meaning of environmental protection and energy saving. It not only concerns the influence of the nature in the process of construction, also begin to focus on the influences of the social and individual quality of life, and pay close attend to health safety of the practitioners.

Secondly, along with the ideas of project life cycle and the work breakdown structure (WBS) have become to the part in the front viewer, consider one project can be divided into different phases or structure, i.e. four phases from Burke (2006) – concept and initial phase, design and development phase, implementation or construction phase and commissioning and handover phase [2]. The concept has been expanded into the whole life cycle of construction project from a certain stage in the construction process. The concept of sustainable construction has been expanded into the whole life cycle of construction project from a certain stage in the construction process. It is not only focus on the certain stage - design, construction or operation, but penetrate the sustainability from the project approval, site selection, until the demolition [15]. This idea also compounded the literal problem of the term of 'sustainable construction', as 'sustainability' is regarded as one can exist forever (IUCN, 1991), it described sustainable construction is a process from planning and design stages continues to it whole life. Figure1. displays the main sustainability tasks that contained during the project process.

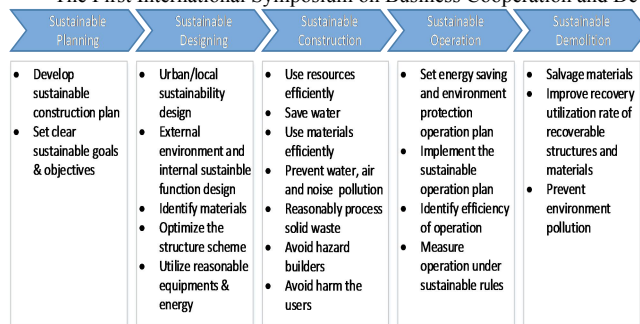


Figure 1. Sustainable Construction Life-cycle

At the last, the attentions switch from simply considering the construction technologies to various special functions. Such as, raise natural ventilation and lighting to reduce energy consumption, or use good temperature retention materials to reduce the heat loss and improving energy efficiency effect.

According to the development of the concept, the sustainable construction can be expounded in the Figure 2. Sustainable construction is regarded as a system with multi-attributes and tasks. It throughout the entire project, and embraces the sustainability issues as energy efficient utilization, environment protection and public's quality of life by different functions.

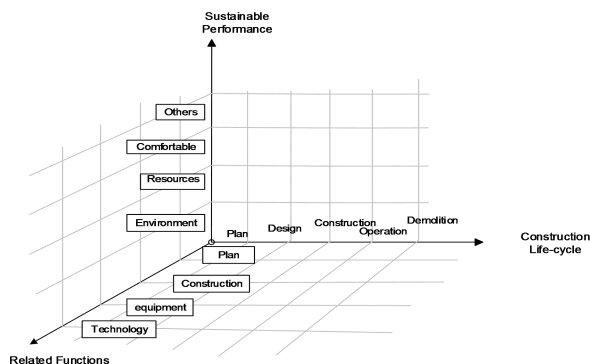


Figure 2. The Framework of Sustainable Construction System

IV. SUSTAINABILITY IN HIGHWAY CONSTRUCTION

Bases on the view from Martland (2010) highway is a construction project, it should be feasible from engineering, financial and social perspectives, it should be built in an effective way to achieve economic benefits greater than costs without negative externalities. Blended into the idea of sustainability Martland (2010) combine the social and environmental aspects in the project management triangle in Figure 3, indicates that a successful infrastructure has to meet the requirements of economic benefits to the owners and management, also take concern on the impacts of public and users on environmental and social aspects. This can be blended into the idea of sustainable development. This view is line with the idea of 'green highway' or 'sustainable highway' as developing the highway to integrate transport functionality and eco-environment sustainability.

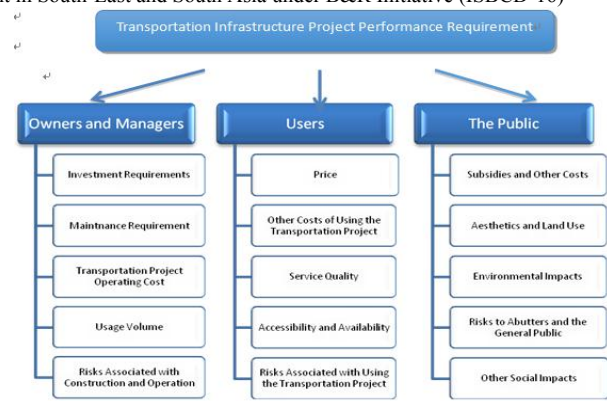


Figure 3. Infrastructure Project Performance Requirements (Martland, 2010)

Sustainable highway requires the projects to meet the needs of mobility, environmental protection, liveability, and safety while achieving economic targets throughout its lifecycles (Department for Transport of UK, 2008). The term of sustainable highway was raised which call for developing environmentally and economically sustainable highways to improve the quality of infrastructure, reduce the cost and increase the capacity of the highway (Bryce, 2008).

As a construction project, the term of sustainable construction is used in the infrastructure [7]. Accordingly, the sustainable highway project can be referred as: through the technologies innovation and management transformation to realize the ecological, economic, culture and social objectives throughout project whole process- planning, design, construction and operation. Develop a product to meet the requirements of society sustainable development – the sustainable construction project. The project has lower natural resources and energy consumptions, use recycling materials. Through the advanced project management methods and technologies to achieve high productivity and energy efficiency.

V. SUSTAINABLE HIGHWAY AND 'ONE BELT, ONE ROAD'

The initiative of building economic belt "silk road" and "Marine silk road" ("One belt, one road") which coincide with promoting the sustainable development agenda in 2030 by United Nations, it is major regional development model of international cooperation. Both have similar development vision and principles, and enhance mutual prosperity and inclusive development.

The strategy of 'One belt, one road' has five key points which has strong relationship with sustainable development, for example, facilities link, trade smoothly flowing and fund circulation, and improvement of the agricultural productivity by cooperation of agriculture, forestry, animal husbandry and fishery sectors. Meanwhile, make contribution to eliminate hunger and realize the food security. Furthermore, the strategy emphasizes the communication between culture, talent, science that will help to create peaceful and harmony society. All of the goals meet the sustainable development.

The highway, which is important to quality of life, development of economics, and has serious environmental and social consequences [3]. However, considering the long-term strategy development, build sustainable highway, should not only meet the current development needs but also leave some space for the future economic and social development. Eventually, help to implement the 'One belt, one road' strategy.

VI. CONCLUSION

However up to now, highway infrastructure is the principal elements of "one belt, one road" strategy, as the strategy states that relying on international highway network on land to build

The First International Symposium on Business Cooperation and Development in South-East and South Asia under B&R Initiative (ISBCD-16) a flow of safe and efficient transport thoroughfare. Meanwhile, the sustainability has become a significant matter for the construction and highway sector. It referred as the green support and direction for realizing the strategy.

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