

Research on construction management innovation system of metro in China

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Abstract: Construction management innovation system of metro in China is put forward in this paper. Guidelines, objective system, new management ideas and contents of this construction management innovation system are set forth particularly. The construction management innovation system of metro can meet needs of building harmonious and economized society and realizing sustainable development in China, it is also an important part of science & technology innovation system.

Key words: metro; construction management innovation system; China

1 Introduction

China is undergoing the largest investment wave of the construction of metro in the history. By the promotion of economic growth and city construction increase, China's metro began to start construction, and has completed operation mileage of 496.94 km during "The 10th Five-Year Plan" period. China's metro construction has entered burst of the growth period during "The 11th Five-Year Plan" period, and China's metro construction has completed 22 operating lines, and the total length has reached 627.42 km at the end of 2006 in mainland. At present, 10 cities including Beijing, Shanghai, Tianjin, Guangzhou, Dalian, Changchun, Chongqing, Wuhan, Shenzhen and Nanjing have opened metro lines. More than 30 cities between 48 mega-cities with population of over 1 million have begun preparatory work of metro, and the recent plans are to build 55 lines with a total length of about 1 700 km, and with a total investment over 600 billion yuan. China's metro construction is booming now. Rapid development of metro construction demands higher requirements on construction management of metro.

2 Necessity of construction management innovation of metro in China

1) Needs of building a harmonious and conservation-oriented society and achieving sustainable development

As a hot investment in China, metro should be implementing scientific concept of development and recycling economy put forward by CPC (Communist Par-

ty of China) Central Committee. Management innovation is the fundamental guarantee for implementation idea of scientific development in metro construction.

2) Needs of China's metro construction

Many cities in China are in construction of metro, which need new management ideas to support their current construction management and existing problems of construction management also need management innovation to solve.

3) Needs of new ideas, theories and methods of modern project management

A lot of new ideas, theories and methods appear in modern project management. Only when these new ideas are implemented timely and promptly, then theories and methods used in construction management of metro can be transformed into productive forces and enhance China's competitiveness of construction management of metro.

3 General structure of construction management innovation system of metro in China

The overall guiding ideology of construction management innovation system of metro is the idea of healthy development, people-oriented, sustainable development, recycling economy put forward by the CPC Central Committee, which can guide the total construction management.

Construction management innovation system of metro is guided by the overall guiding ideology, based on one objective system, applied of modern project management of new ideas, theories and methods to innovate the contents of construction management of

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metro. Its general structure is shown in Fig. 1.

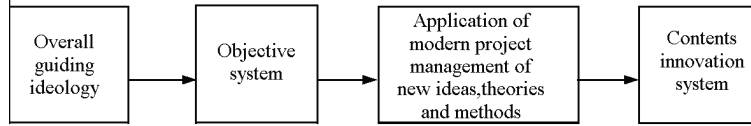


Fig. 1 General structure of construction management innovation system of metro in China

4 Objective system of construction management innovation of metro in China

Objective system of construction management innovation of metro in China can be decomposed from two different angles, one is from the perspective of total lifecycle, and the other is from the perspective of objective system structure method.

4.1 Objective system decomposed from the perspective of total lifecycle

Objective system of construction management innovation of metro in China is a project objective system which can appear the total lifecycle theory, and can be divided into four dimensions as sustainable development, coordination with environment, satisfied by every participant and three main objects (broad sensed quality, cost and time), as shown in Fig. 2. Among them, sustainable development is the object of philosophy and thinking level, and is also the goal of the highest level.

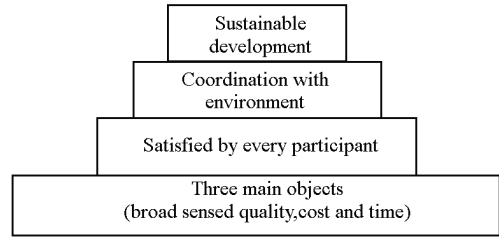


Fig. 2 Objective system decomposed from the perspective of total lifecycle

4.2 Objective system decomposed from the perspective of objective system structure method

In accordance with objective system structure method, objective system of construction management innovation of metro in China can be divided into three levels: general objective, sub-objectives and executable objectives, as shown in Fig. 3.

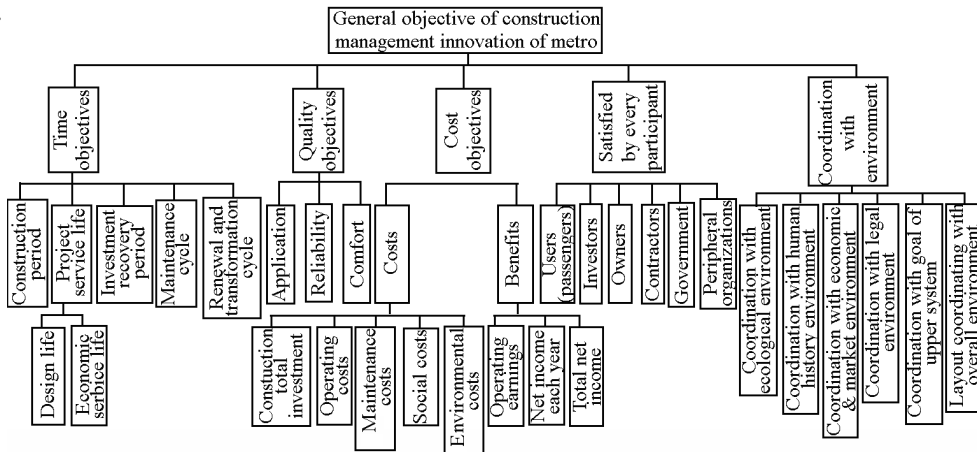


Fig. 3 Objective system decomposed from perspective of objective system structure method

General objective of construction management innovation of metro in China is to play the regional advantages, highlight the regional characteristics, use of resources reasonably, strengthen coordination between metro and other modes of transportation so that metro construction can be ahead of needs of socio-economic

development appropriately, and achieve sustainable development of metro construction when providing effective protection for sustainable development of socio-economic.

Sub-objectives of construction management innovation of metro in China are shown as following:

1) Time objectives: according to total lifecycle management of metro, time objectives include construction period, project service life, investment recovery period, maintenance cycle and renewal and transformation cycle. And project service life includes:

a. Design life: determined from the structural strength of tunnel and station, construction method, and so on.

b. Economic service life: ended at point in time that the value of the maintenance less than the value of redevelopment under the premise of metro's various parts meeting demand for predetermined service function.

2) Quality objectives: quality objectives of construction management of metro during lifecycle pursue uniformity of work quality, engineering quality, final product function and quality of product or grade of service, and focus more on the integrated function of technology systems, technical standards and security. These can be mainly included in three objectives as application, reliability and comfort.

3) Cost objectives: cost objectives of construction management of metro should consider all the relevant costs and benefits during life cycle comprehensively as following:

a. Total lifecycle costs: include construction total investment, operating costs, maintenance costs, social costs, environmental costs, and so on.

b. Benefits: include operating earnings (ticketing revenue, etc.), net income each year, total net income, and so on.

4) Satisfied by every participant: one successful metro construction can meet needs of all participants, including users (passengers), investors, owners, contractors (including designers and suppliers), government, and peripheral organizations.

5) Coordination with environment: this object includes coordination with ecological environment, human history environment, economic and market environment, legal environment and goal of upper system and layout of metro should coordinate with overall environment.

Executable objectives: executable objectives are further refinement of sub-objectives and description of sub-objectives has actually included some executable objectives. Executable objectives have multiple levels, only part of them have been listed in Fig. 2, and can be further decomposed. Objective system of construction management innovation of metro in China is a complex multi-factor system, and executable objectives selecting should follow principles of scientific and applicability, comparability, systematic and operational.

5 New management ideas, theories and methods innovation of metro

5.1 Total lifecycle integration theory

The total lifecycle of one project refers to the entire process from project idea starting to construction project abandonment (or the end of the project). In the total lifecycle, the project experienced four stages as earlier planning, design and planning, construction and operation. Metro has its own lifecycle, and can also be roughly divided into four stages of the above. Work of earlier planning stage includes network planning, line planning, feasibility studies and other work. Work of design and planning stage includes the general design, individual design and bidding work of civil engineering, materials, and so on. Work of construction stage includes civil engineering construction (including stations engineering, tunnels civil engineering, the track laying work, etc.), equipment installation, commission and integrated test. Work of operational stage includes test operation and operation. Various stages will overlap in time for one line, and various stages of different lines will also overlap in time, which put forward higher requirements for total lifecycle management of metro. So total lifecycle integration management of metro not only aims at the single line at all stages of lifecycle, but also focuses on various stages of different lines.

5.2 Integration management method

Content of integration management method of metro should include the following five areas:

1) Integration of various stages of total lifecycle

Integration of various stages of total lifecycle is to establish metro system logic process, and integrate all works during the total lifecycle, including network planning, line planning, objective system design, feasibility studies, design (general design and individual design) and plan, implement control, operation management together, in order to form total lifecycle management.

2) Integration of all management functions

Integration of all management functions use PBS (project breakdown structure) as the main line to link up cost management, schedule management, quality management, contract management, resource management and responsibility system. Integration management requires its managers should carry out objectives management of total lifecycle, comprehensive plan, comprehensive control and good interface management, good coordination and communication.

3) Integration of project organizations and responsibility

Through objective design and organizational responsibility of total lifecycle design, blind spot of organizational responsibility projects can be eliminated and short-term behavior of project participants can be avoided, so that the entire project organization of metro engineering can be operated of the barrier-free communication.

4) Integration of information

Integration of information needs to establish information platform which can enable all participants to share information, so that information of construction management of metro can be barrier-free communicated in the entire process of project, project members of various organizations and various function management departments.

5) Integration of different lines

Integration management of metro is not only for a single line, but also pay greater attention to integration management of different lines of network. Integration management of different stages of lifecycle, different functions, project organizations and responsibility and information between different lines of network should be considered.

5.3 Sustainable development theory

Sustainable development is China's basic national policy and sustainable development of project is part of the strategy of sustainable development. Sustainable development theory used in construction management of metro appears as researches on concepts, principles and theories of sustainable design, sustainable architect and sustainable construction, and so on, whose essence is to research on sustainable development issues during design and construction stage from the total lifecycle perspective. The idea of sustainable development used in projects reflects the applications of the concept of healthy development, recycling economy and green economy.

Sustainable development is one of the objects of metro engineering and also social requirements of it. With theoretical guidance of sustainable development, China's metro construction can develop healthily, rapidly and sustainably, and China can build a resource-saving and environment-friendly transportation system to guide urban traffic on environmental protection, energy saving and human-centered of the road of sustain-

able development, in order to promote city sustainable economic and social development.

5.4 Mission of metro engineering

A successful project should be of historical value. The mission of engineering is on behalf of commitment of builders to the society and history, embodies the core values of engineering, and is moral foundation of project participants^[1]. Metro engineering needs huge investment, consumption of resources, and has construction and operation of a long period, so only should it have great historical responsibility and social responsibility can be called a successful project. Metro construction must be in the strengthening of social responsibility and historical responsibility in its process and organizations, which includes meaning of the following three levels:

1) Satisfying requirements of the upper system^[2]. For metro engineering, the most fundamental goal is to afford suitable urban rail transport services for the community by operating, in order to solve the city's traffic congestion problem.

2) Committing social responsibility. Metro construction needs huge investment, consumption of the social and natural resources, and has big impact on the environment. Therefore, metro engineering has great social responsibility, must meet interests and expectations of stakeholders and requirement of all parts of society, should be coordinated with the environment, and gain satisfaction of all aspects of society.

3) Bearing historical responsibility. Construction and operation (using) of one metro line needs process for decades, even centuries. Therefore, metro engineering should not only meet the needs of contemporary people, but also bear historical responsibility to continue to meet the future needs of its people, must have their historical value.

6 Contents innovation system of construction management of metro

Contents innovation system of construction management of metro in China embodies objective system of construction management innovation of metro, and is also application of modern management idea innovation of metro, as shown in Fig.4.

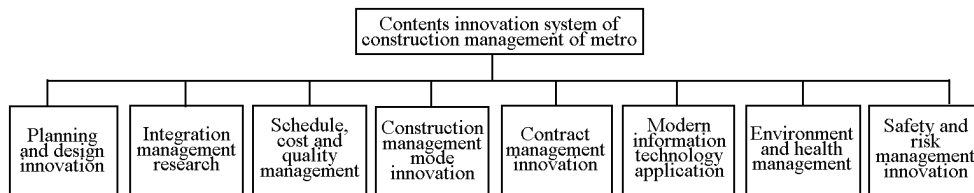


Fig.4 Contents innovation system of construction management of metro in China

6.1 Planning and design innovation

Special nature of metro engineering makes its planning and design management has its particularity. Planning and designed of metro engineering is key to establish sustainable development of urban rail transport system, and plays a very important role to construction and operation of metro.

Planning and design innovation of construction management of metro establishes integration system as “planning – design – construction – supply – operation maintenance – expansion”, builds planning system as “regional development strategy – urban development – transportation planning – network planning of metro – line planning of metro”, and advances ideas of energy-saving design, human-centered design, construction design, reparability (maintenance) design, scalability design, reliability and safety design and ideas of dealing with unexpected incidents by applying total lifecycle integration idea of metro into design process.

6.2 Integration management research

Construction management system of metro is based on management of complex system, so only integration can metro system achieve coherence and coordination, and realize its overall optimization. Integration management research of metro can realize total lifecycle management of planning, design, construction and operation of metro, and improve overall management functions and effects.

Integration management research of metro includes comprehensive plan and comprehensive control study of metro system, emphasizes integration management of single line and coordination of lines of metro network.

6.3 Schedule, cost and quality management innovation

Schedule, cost and quality management is the foundation to achieve three major objects of construction management of metro, and research on schedule, cost and quality management innovation is the necessary content included in construction management innovation system.

Schedule, cost and quality management innovation of metro researches on schedule management innovation, cost management innovation and quality management innovation separately. On schedule management innovation, schedule management system of metro is established and the limits of China’s metro are calculated to provide basis for schedule optimization. On cost management innovation, idea of cost integration management is advanced. On quality management innovation, quality lifecycle management system of metro is established.

6.4 Construction management mode innovation

Construction management mode of metro mainly means the organization management model during construction and operation period of metro.

According to characteristics of concurrent of a number of tenders of construction and concurrent of construction and operation, new construction management mode is advanced which is called concurrent program management mode, and structure and operation of this new management mode is researched.

6.5 Contract management innovation

Construction and operation of metro is based on contracts, so contracts play a binding role for project participants of metro. Contracts of metro have diverse forms and contract management is at the center position in project management, therefore, contract management innovation is living in the very important position in construction management innovation system.

Contract system and contract coding system according with metro’s characteristic is established, and new contract idea, contract terms are applied to different types of contracts of metro (such as construction contracts, material procurement contracts, survey contracts, supervision contracts, etc.), so that the whole contract system can be more integrated.

6.6 Modern information technology application

Modern information technology in construction management of metro can achieve the barrier-free communication of information, reduce lifecycle costs and improve management efficiency.

Lifecycle information system is established, BIM application in construction management of metro is analyzed, common platform of all participants established by PIP is designed, and application of virtual technology in construction management of metro is discussed.

6.7 Environment and health management

Environment and health management of metro is necessary for achieving sustainable development and coordinating with environment, and also an important part of construction management innovation system of metro.

Lifecycle environment management (including environment management system of metro engineering, environment management of stakeholders and technical measures of environment management, etc.) and health management of metro is set up.

6.8 Safety and risk management innovation

High requirements of security are needed for metro construction, so that high requirements are also needed for risk management of metro construction, therefore, safety and risk management innovation is a neces-

sary component of construction management innovation system of metro.

According to security requirements of metro construction, comprehensive safety system and lifecycle three-dimensional integrated risk management system are founded.

7 Conclusions

During “The 11th Five-Year Plan” period, China’s metro construction comes into high-speed development period, and research on construction management innovation system of metro will play a vital impact on its development. Construction management innovation system of metro is guided by the overall guiding

ideology, based on its objective system, applied of new ideas, theories and methods of modern project management to innovate contents of construction management of metro. As part of China’s scientific and technological innovation system, construction management innovation of metro in China plays a very important role in metro construction innovation and metro management innovation of China.

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