

# Study on Factors Influencing the Reliability of the Organization Management Chain of the Large and Medium-Sized Project in the Construction Period

Jingchun Feng<sup>1</sup>, Yao Qian<sup>1</sup>, Zhanjun Liu<sup>2</sup>, Haiyang Li<sup>2</sup>

<sup>1</sup>*Business School, Hohai University, Nanjing, China*

<sup>2</sup>*The Major Middle Route Construction Administration of the South-to-North Water Transfer Project, Beijing, China*

*E-mail: olay\_1986@126.com*

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## Abstract

On the basis of analyzing the reliability of the organization' management chain of the large and medium-sized project in the construction period, the paper studies the factors influencing the reliability of the organization management chain, which, corresponding to four elements of management chain—"Management Loop", "Management Link", "Management Chain", and "Management Network", can be summarized as project main body, interface management, connection sequence and management model. The paper then researches on the specific influencing factors from the above-mentioned four aspects.

**Keywords:** The Large and Medium Sized Project, the Reliability of the Organization Management Chain, Influencing Factor

## 1. Introduction

The reliability of the management chain directly affects the smoothness and effectiveness of the transmission of construction management order, business process, message, etc [1]. As there is a large number of participating units and interfaces in the construction period of large and medium-sized projects, the models of construction management are diverse, management relationship is complex, and project uncertainties are great, thus impacting the reliability of the management chain. Therefore, it needs to research on factors influencing the reliability of the management chain, and identify the main factors which affect the reliability of the management chain, to lay the foundation for further quantitative analysis and research. This paper defines the content of the reliability of management chain, and conducts a qualitative study on the main influencing factors.

## 2. The Content of Project Organization Management Chain and Its Reliability in Construction Period

### 2.1. The Content of Project Organization Management Chain

Project organization management activities are essen-

tially a process in which the managed is influenced by managers [2]. In numerous management hierarchies of project organization, management activity at each level can be abstracted as "Management Loop", and two adjacent management loops that contact a lot form a "Management Link", a number of "Management Link" form a "Management Chain", and a number of "Management Chain" form a "Management Network". Therefore, the basic elements which constitute the organization management chain of the large and medium sized project are "Management Loop", "Management Link", "Management Chain", and "Management Network".

### 2.2. The Content of Reliability and the Reliability Degree of Management Chain

#### 2.2.1. The Content of Management Chain Reliability

In reliability engineering, reliability is defined as the ability of the product to complete the function within the specified time and under specified conditions [3]. Based on the characteristics of the management chain of large and medium-sized projects in construction period, the management chain reliability can be defined as: the ability of the management chain system to normally transmit management work flow, logistics, and information flow according to management functions within the specified

time.

The understanding of its content can be divided into the following four aspects:

- 1) The prerequisite to discuss the reliability of management chain is “within the time limit,” that is, if completing required function outside the specified time, it will still be regarded as failure.
- 2) The workflow, logistics, information flow transmitted by a reliable management chain should be determined in accordance with management functions.
- 3) Transmission of information flow is the link between the work flow and logistics transmission, it reflects, control and command the other two.
- 4) Normal delivery refers to no error, delay, inefficiency and other conditions in the transmission process.

**2.2.2. The Content of the Management Chain Reliability Degree**

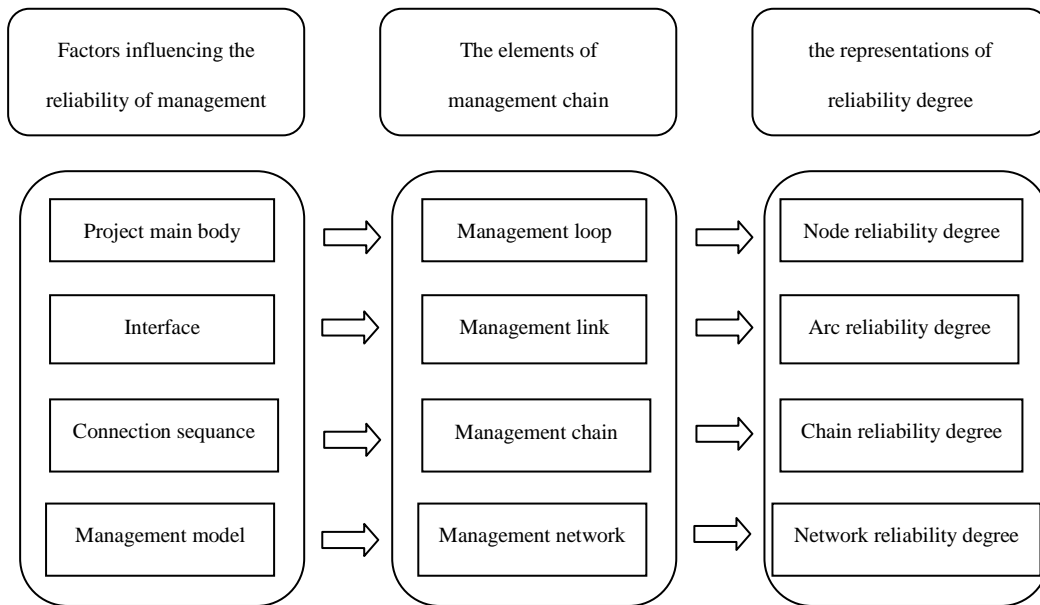
An important indicator measuring the management chain reliability is reliability degree [4]. The management chain reliability degree refers to the probability of the management chain system to normally transmit management work flow, logistics, and information flow according to management functions within the specified time. The reliability of the management chain depends on both node reliability degree and arc reliability degree, node *i* and its following arc *i-j* are combined to become a basic unit of the management chain, expressed by [*i,j*], and its reliability degree is the product of the node reliability and arc reliability, expressed as  $R_{ij} = r_i \times r_{i-j}$ .

**3. Analysis of Factors Influencing the Reliability of Organization Chain in Project Construction Period**

Factors influencing the reliability of organization chain in project construction period are related to construction management model, main body’s self-reliability, the interfaces between main bodies, and the connection sequence of management chain and influencing factors can correspond to the elements of management chain, and the representations of reliability degree, as shown in **Figure 1**.

**3.1. Construction Management Model**

Construction management models of large and medium-sized project consist of direct management model by project legal person, agent construction model and agent management model (it can be divided into direct mandatory management model and mandatory plus agent construction management model). In the construction management of large and medium-sized project, it needs to select appropriate management model according to state regulations, project characteristics, and the situation of project legal person. As different construction management models can alter the levels and categories of project main body, thus affecting the categories, forms, and connections of interfaces between the main bodies in organizations. Therefore, construction management model offers a framework for the formation of a management network which determines the management between main bodies, interface relationship, composition of various management



**Figure 1. Corresponding relation of influencing factors, the elements of management chain, and the representations of reliability degree.**

chains and the management network that is composed of various crisscross management chains. Thus the whole reliability of the management network will be influenced by the management model of the large and medium-sized project in construction period.

### 3.2. The Reliability of Main Bodies

The main bodies of the large and medium-sized project can be generally divided into three levels: first, the main body at the level of government administrative control. It contains the main bodies of government industrial management and administrative supervision management; second, the main body at the level of project construction management. It contains the main bodies on markets, like project legal person, project management enterprises (agent management enterprises or agent construction enterprises) that could undertake the large and medium-sized project, design institutes, supervision companies, construction enterprises, and supply enterprises; third, the main body at the level of decision consultation. It includes expert commission of large and medium-sized project.

The main bodies of the large and medium-sized project are equivalent to the basic element of management loop in management chain, and it represents as node reliability degree in the management chain reliability degree. The nature, interest orientation, organizational structure and culture of the main bodies in the large and medium-sized project are various, which will affect the reliability of the main bodies. Different nature of main body as government, enterprise, public institution have different reliability; according to different interest orientation, organizational structure and culture etc, the reliability of project legal person, design institution, construction enterprise, agent construction enterprises or agent management enterprises can be different. Even if both are construction enterprises, their reliability can still be different because of the difference of origination and culture etc.

### 3.3. The Interfaces between Main Bodies

The interfaces between main bodies of the large and medium-sized project are equivalent to the basic element of management link in management chain, and it represents as arc reliability degree in the management chain reliability degree. With the purpose of successful transmission of management work flow, logistics, information flow between project main bodies, the interfaces must be kept smooth and stable.

Interface reliability depends on three factors: the interface protocols, interface formats and relational con-

straints which include government relationships, contractual relationships, clientage relationships and coordination relationships.

1) Government management relationships. The government management relationships refer to the management relationships between government and project legal person, construction enterprises, supervision companies, and the suppliers, including administrative management and supervision management relationships.

2) Contract relationships. The relationships between the project legal person and construction enterprises, supervision companies, the suppliers are contract relationships.

3) Clientage relationships. The relationships between project legal person and agent construction enterprise, agent management enterprise are the clientage relationships.

4) Coordination relationships. The relationships among government, project legal person, consultation enterprises, suppliers, and among supervision companies, construction enterprises, the suppliers are coordination relationships.

Among them, clientage relationship is realized by clientage contact, thus it can be seemed as a kind of contract relationship. So the management relationships can be divided into administrative management relationships, supervision relationships, contract relationships, and coordination relationships. The reliability of the four relationships is different from one another, thus affecting the reliability of the interface and the arc reliability of management chain.

### 3.4. Connection Sequence of Management Chain

In the process of transmitting construction management work flow, logistics, information flow of large and medium-sized project, the connection sequence may affect the reliability of management chain.

1) The management chain in which upper management loop transmits flow to downstream management loop. It refers to the management chains developed by flow transmission from government to project legal person, project management enterprises, construction enterprises, supervision companies etc.

2) The management chain in which downstream management loop transmits flow to upper management loop. It refers to the management chains developed by flow transmission from construction enterprises to government, project legal person, project management enterprises, supervision companies etc.

3) The management chain in which middle management loop transmits flow to upper and downstream management loop. It refers to the management chains

developed by flow transmission from project legal person to government or to project management enterprises, construction enterprises, supervision companies; the management chains developed by flow transmission from project management enterprises to government, project legal person or to construction enterprises, supervision companies; the management chains developed by flow transmission from supervision companies to government, project legal person, project management enterprises or to construction enterprises etc.

#### 4. Analysis of the Influence of Construction Management Model on Reliability

##### 4.1. Type of Construction Management Model

Project construction management model refers to the basic organizational model in project construction and the roles that all participation parties play and their relationships in implementation phase. Project construction management models include basic construction management model and its evolutionary patterns. The paper discusses only the basic ones, which can apply equally to

the evolutionary patterns for the reason that they evolve from the three basic models.

The basic construction management models of large and medium-sized project consist of direct management model, agent management model, and agent construction model, as shown in **Figure 2**, **Figure 3**, and **Figure 4**.

##### 4.2. Enthusiasm and Professionalism

Large and medium-sized projects typically include the principal projects, local supporting projects, ecological and environmental protection projects, and the latter two projects as well as coordination, land acquisition and resettlement projects are undertaken by local project main bodies, thus, it needs to adjust the responsibilities and interest relationships of many regions and departments. At the social management level, effective management can only be achieved through the effective cooperation and coordination of central and local government and relevant departments [5]. Compared to direct management model, agent management model (that is, to commit part of the project to local governments, relevant

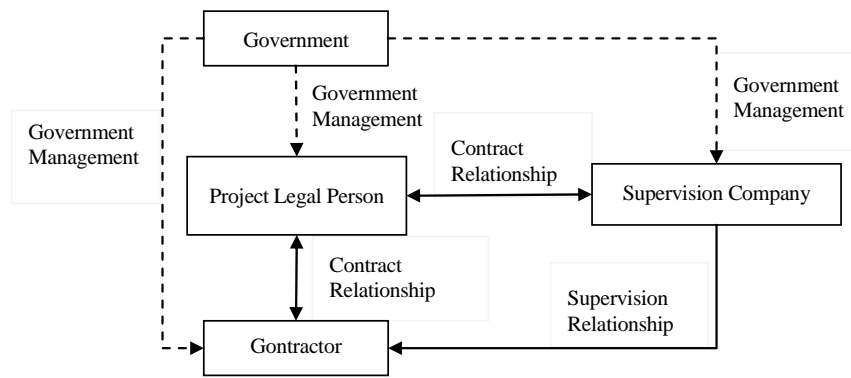


Figure 2. Direct management model.

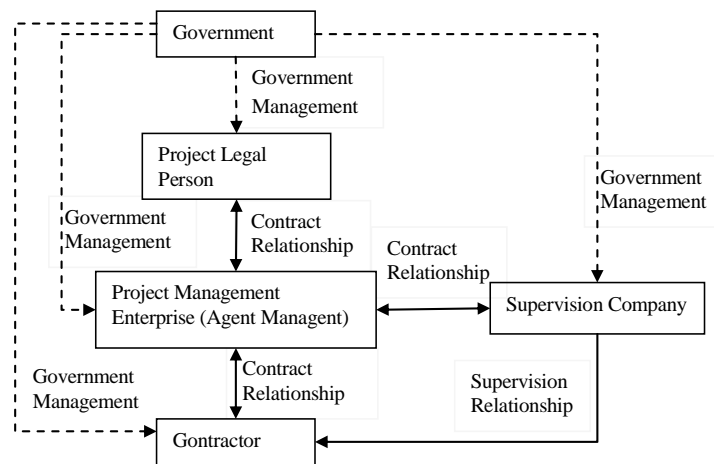


Figure 3. Agent management model.

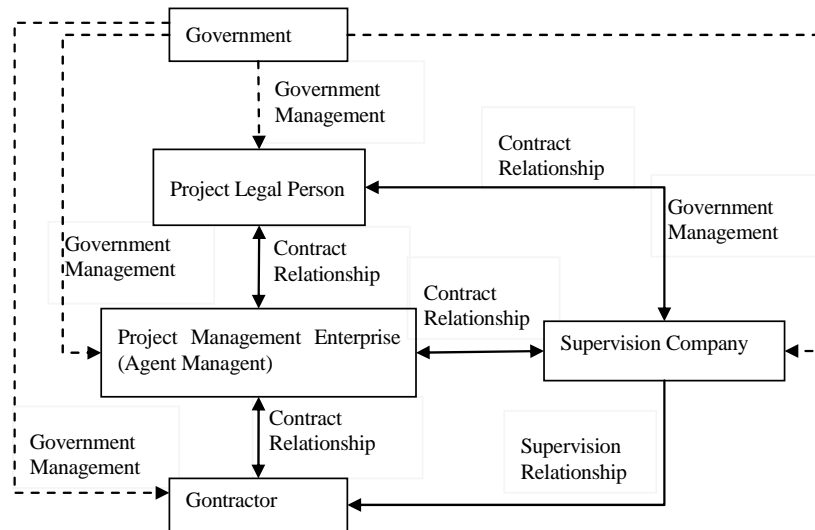


Figure 4. Agent construction model.

departments, and enterprises) can fully mobilize the local government, relevant departments, and enterprises to improve the reliability of management chain.

Compared with direct management model and agent management model, agent construction model takes the full use of market selection mechanism and social management resources, which will help promote fair competition, improve management level, reduce administrative costs, thereby improving the reliability of management chain.

### 4.3. Containment of Corruption

Under the model of direct management and agent management, the project legal person and project management enterprises are nominally independent from the government, but in fact they are vulnerable to be controlled by government and prone to corruption. Agent construction model, on the other hand, can separate the phases of “investment, construction, management, use”. The separation and mutual check of every phase can avoid the concentration of rights and isolate the direct interest relationships of main bodies, which, to a certain extent, can contain corruption and improve reliability of management chain.

### 4.4. The Number and Location of Interfaces

From a macro perspective, the interfaces can be divided into near outer layer ones (with a contractual relationship) and far outer layer ones (without contractual relationship).

1) Near outer layer interfaces. Under the direct management model, the interfaces are between project legal person and supervision (or consultation) units, work

contract enterprise. Under the agent management model, the interfaces are between project legal person and project management enterprise (agent management), and among project management enterprise (agent management), supervision (or consultation) units, and work contract enterprise. The interfaces are between project legal person and project management enterprise (agent construction), and among project management enterprise (agent construction), supervision (or consultation) units, and work contract enterprise in the agent construction model.

2) Far outer layer interfaces. Under the direct management model, the interfaces are among government, project legal person supervision (or consultation) units, and work contract enterprise. Under the agent management and agent construction model, it increases interfaces between government and project management enterprise (agent management or agent construction enterprise).

Difference of construction management models will change the number and location of interfaces, thus changing the connections of management chain and entire management network, and having an impact on reliability.

### 4.5. Management Workflow

For the direct management model, the management functions of project legal person are directly management on the quality, schedule, safety, funding, acceptance, and file. Under the agent management and agent construction model, however, project legal person will transfer some of the rights and obligations to the project management company (agent management or agent construction)

through entrusted agency mode.

## 5. Analysis of the Influence of Main Body on Reliability

### 5.1. Interest Orientation of the Main Body

The different status of organizations in large and medium-sized projects results in different interest orientations. The interest orientations of project main body are shown in **Table 1**.

The interest orientation of main bodies will affect their reliability. For instance, the work contract enterprises will efficiently complete the transfer of work and information flow when it comes to work payment, while they have low reliability on the transfer of work and information flow in terms of environmental protection; the government has high reliability on the transfer of work and information flow at macro-level, for example, the environmental protection level, etc.

### 5.2. Organizational Structure [6,7]

In the construction of large and medium-sized project, there are not only long-term business organizations but also temporary project organizations. Different forms of organizational structure lead to difference in the division of management functions, work flow, information flow, resource utilization, procedures and ways of response to external environment, thus affecting the reliability of organization management. There are five common organizational structures including linear type, function type, linear-function type, project type, and matrix type. Their impacts on the reliability are shown in **Table 2**.

### 5.3. Organizational Culture [8,9]

Organizational culture can exert influence on the reliability

**Table 1. The interest orientation of project main body.**

Project main body	Interest orientation
Government	Safeguard social and ecological benefits
Project legal person	Realize investment objectives and pursue the best investment economic efficiency
Project management enterprise (agent management or agent construction)	Realize objectives of agency contract, get profits
Design institution	Realize objectives of design contract, get profits
Supervision company	Realize objectives of supervision contract, get profits
Work contract enterprise	Realize objectives of contract agreement, get maximum profits

of main body from internal and external aspects.

1) Spiritual aspect. It exerts influence on the reliability through organization's values, business philosophy, for example, under the bureaucratic culture, the decisions of leaders can't be easily rejected, decision making is slow, thereby affecting the efficiency of management and team morale.

2) Behavior aspect. It affects reliability through the organization's management system, behavior manner, etc. For example, the organizational culture can either promote departmental independence or close communication and collaboration between difference departments; either promote innovation or caution, the choice of which will affect the reliability of the main body.

### 5.4. Interest-Related Party

Organization's interest-related party can influence the target or be influenced by the target of the organization, and it can be divided into major and minor interest-related ones. In the large and medium-sized project, each participating party is the others' major interest-related party, and the public around, project communities, banks, government audit departments are minor interest-related ones. Interest-related parties have an influence on the organization's decisions and actions, thereby affecting the organization's management performance. The more important role interest-related party plays, the greater impact it will exert on the reliability of project main body.

**Table 2. The impact of the organizational structure on the reliability.**

The type of organizational structure	The impact on the reliability
Linear type	Positive: unified command, specified rights and responsibilities, rapid transmission of various flows Negative: affecting the reliability for lack of function-division and long transmission path
Function type	Positive: a clear division of management functions to improve the reliability Negative: multiple leadership causes confusion, relatively slow transfer of all flows
Linear-function type	Positive: unified command, a clear division of management function Negative: may lead to long path and slow speed while transferring flow
Project type	Positive: a clear target, unified command, quick response Negative: lack of information sharing between projects
Matrix type	Positive: a clear target and effective use of resources Negative: dual leadership cause unclear responsibilities, thus lower the efficiency of team work, communication and transmission of information

## 6. Analysis of the Influence of Interface on Reliability

### 6.1. Interface Agreement [10,11]

Only by complying with certain rules—interface agreement—can the “management loop” be effectively connected, so as to smoothly realize the function of management chain of transmitting workflow, logistics, information flow, and ensure the efficient and ordered project construction.

Interface agreement affects the reliability from the following aspects:

- 1) Whether clearly define the scope and limits of the interface on both sides;
- 2) Whether set a time sequence that the work on both sides of the interface can be linked by a reasonable sequence and direction;
- 3) Whether it can guarantee the timeliness of transmission so that the time and progress of interface exchange can be implemented as scheduled;
- 4) Whether it can clearly trace back to the subject of liability of interface work.

### 6.2. Interface Format [12]

Interface formats are various, such as reports, documents, reports, drawings, images, audio, video, interface. Interface format reflects the format request of information transmission proposed by related parties of the interfaces. If the format fails to comply with the requirement, it will result in an interface conflict, which will affect the reliability of the interface. Different interface formats can also affect its reliability. For example the information is prone to delay, distortion, excess, and loss for the transmission of the paper documents.

### 6.3. Relationship Constraint

#### 6.3.1. Government Administrative Relationship

Government administration relationship affects the reliability from the following aspects:

- 1) Government administrative powers. Administrative power can directly impose compulsive dominant influence on natural persons, legal persons, and unincorporated organizations, and it adjusts various interests in accordance with the will of state. It is the decisive factor that ensures the reliability of government administrative relationship.
- 2) Effectiveness of government administrative acts. It includes determination force, binding force, facto force, executive force. The effectiveness of administrative acts guaranties it will not be changed when effectively estab-

lished; it has legally binding power towards relevant person or organization; it will presume to be valid whether legal or not, and relevant parties shall conform and obey; administrative subject has the right to take certain measures to implement administrative acts. The effectiveness of administrative acts is an important factor to ensure the reliability of government administrative relationship.

3) Government administrative supervision. It carries out supervision on administrative department and staff, which could ensure the effectiveness, fairness, legitimacy of the public power operation and prevent corruption, thus affecting the reliability of government administrative relationship.

#### 6.3.2. Contractual Relationship

Contractual relationship affects the reliability from the following aspects:

- 1) Contract completeness. Whether the terms of the contract is detailed, whether the contract provides the specific response measures for both parties if unforeseen event happens, whether the contract institutes strict rules on the project changes and claims.
- 2) Strict performance of the contract. Whether the contract has strong legal binding power on both parties, and whether the breaching party would receive severe legal sanctions and financial penalties.
- 3) Contract security system. Whether to implement the contract responsibility system, formulate contract management procedures, and improve document management system.
- 4) Administrative supervision of contract [13]. It affects the reliability of contractual relationship through the whole process of main bodies' qualification authentication by administrative department, bidding, act of signing contract, tracking and inspection on the performance of the contract, and examination after fulfillment of the contract.

#### 6.3.3. Coordinative Relationship [14]

Effective coordination among the organizations can make organizations work closely and interfaces work smoothly, thus improving the reliability degree of management chain. Outside coordinative relationship of organizations consists of near outer layer coordination that have contractual relationship, and far outer layer coordination that does not have contractual relationship. It is largely the near outer layer coordination affecting the reliability of organization management chain in project construction period. It affects the reliability from the following aspects:

- 1) Coordination among the organizations. The coordination between contractors, or contractors and project legal person mainly relay on the supervisor. Whether the

supervisor, as a third party organization, can balance the interest of the main bodies based on the contract, make information pass correctly, and coordinate the work of all parties, will affect the reliability of management chain.

2) Coordination among the project construction, rehousing, and land acquisition. Whether the project legal person can coordinate the rehousing and land acquisition according to the policies, regulations and standards so as to carry out construction as scheduled will affect the reliability of management chain.

#### **6.3.4. Supervision Relationship [15,16]**

Supervision relationship affects the reliability from the following aspects:

1) The rationality of system of supervision agency. Whether there is a clear division of labor, good communication, no problem of separation of departments, multihead management and overlap supervision in the supervision agency of large and medium-sized project, and whether the supervision is standardized, institutionalized, and routinized, all of these have an influence on the reliability.

2) The independence of function of supervision. Whether the government supervision agency has its definite and independent management function and its relationships with other administrative bodies, whether it is a regulatory agency that is independent from other interest groups, all of these affect the reliability.

3) The fairness of supervision. When carrying out the function of supervision, the supervision agency itself is lack of effective balance and supervision. Whether there is a strong social power, public opinion or other outside supervision power to ensure the fairness of supervision will affect the reliability.

### **7. Analysis of the Influence of Connection Sequence on Reliability**

#### **7.1. Connection from Upper Management Loop to Downstream Management Loop**

The management chain in which upper management loop transmits flow to downstream management loop usually refers to the orders and instructions passed downwards. It means the upper management loop releases plan, measures, decisions, suggestions, management methods, etc, and the downstream management loop executes them. It has fairly high reliability.

#### **7.2. Connection from Downstream Management Loop to Upper Management Loop**

The management chain in which downstream manage-

ment loop transmits flow to upper management loop generally refers to upward transfer of the work. It means downstream management loop reports the work to upper management loop, putting forward their opinions, suggestions and requests, to express their attitude. In the process of upward transfer of the work, the details of the information is ignored and deleted, and will not attract much attention, thus affecting the reliability of management chain.

#### **7.3. Connection from Middle Management Loop to Upper and Downstream Management Loop**

The management chain in which middle management loop transmit flow to upper and downstream management loop can transform into the above two forms. However, compared to those extreme forms, it has fewer loops and links, so the reliability of such management chain would change.

### **8. Conclusions**

1) The factors influencing the reliability of the organization management chain include project main body, interface management, connection sequence and management model, which correspond to four elements of management chain: "Management Loop", "Management Link", "Management Chain", and "Management Network".

2) The factors of management model that influence the reliability are enthusiasm and professionalism, containment of corruption, the number and location of interfaces, management workflow; the influencing factors of the main body are interest orientation of the main body, organizational structure, organizational culture, interest-related party; the responsibility-influencing factors of interface are interface agreement, interface format, relationship constraint (government administrative relationship, contractual relationship, coordinative relationship, supervision relationship); and the influencing factors of connection sequence are connection from upper management loop to downstream management loop, connection from downstream management loop to upper management loop, connection from middle management loop to upper and downstream management loop.

3) The analysis and study on the reliability-influencing factors of the organization management chain can lay the foundation for quantitative research and the optimization of management chain.

### **9. References**

[1] J. C. Feng, *et al.*, "Reliability Model of Organization



- Management Chain of South-to-North Water Diversion Project during Construction Period,” *Water Science and Engineering*, Vol. 1, No. 4, June 2008, pp. 107-113.
- [2] W. U. Limin, “The Discussion on Theory of Management Chain,” *Journal of Wuhan Polytechnic University*, Vol. 22, No. 4, 2003, pp. 83-85.
- [3] B. Guo, *et al.*, “System Reliability Analysis,” Defence Science University Press, Changsha, 2002.
- [4] C. H. Chen, *et al.*, “Construction of the Supply Chain Based on the Reliability,” *Industrial Engineering and Management*, Vol. 9, No. 1, 2004, pp. 72-74.
- [5] B. Z. Du, “The Understanding of the Project Delegating Construction Management Model in South-to-North Water Diversion Project,” *Hebei Water Resources and the South-to-North Water Diversion*, No. 4, 2008, pp. 1-2.
- [6] Mid-South Design & Research Institute, Hohai University, “Contract Project Management Theory and Practice,” China Water Power Press, Beijing, 2009.
- [7] Z. F. Yu, *et al.*, “Project Organization,” Tsinghua University Press, Beijing, 2000.
- [8] W. Z. Gao, “The Research on Characteristics of Organizational Culture Systems,” *Market Modernization*, No. 5, 2006, pp. 86-87.
- [9] E. Schein, “Organization Culture,” *American Psychologist*, Vol. 9, No. 2, 1990, pp. 45-53.
- [10] T. Jing, “Potential Risks and Countermeasures of Subway Project Interface Management,” *Sichuan Building*, No. 5, 2006, pp. 181-184.
- [11] M. Li, “Interface Management in Construction Project,” *Optimization of Capital Construction*, Vol. 27, No. 5, 2006, pp. 32-34.
- [12] Y. Qi, “The Research on Key-Indexes-Oriented Interface Management System of Nuclear Power Plant Project,” Harbin Engineering University, Harbin, 2008.
- [13] Q. H. Zhao, “The Administrative Supervision of Construction Works Contract,” *Construction Management Modernization*, No. 3, 2001, pp. 32-34.
- [14] S. X. Luo, *et al.*, “The Research on Project Coordination Management,” *Value Engineering*, No. 7, 2008, pp. 131-134.
- [15] H. Yu, “On the Government Regulation in Administrative Reform,” *Jianghai Academic Journal*, No. 1, 2004, pp. 76-79.
- [16] B. Sun, “The Research on Supervision Mode of Major National Projects,” Hohai University, Nanjing, 2003.