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Research of BE550 rigs transportation projects

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RESEARCH OF BE550 RIGS TRANSPORTATION PROJECT

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DECLARATION

I certify that all material in this research paper that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this research paper reflect my own personal views, and are not necessarily endorsed by the University.

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ABSTRACT

Title of Research Paper: **Research of BE550 Rigs Transportation Project**

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The research paper is a study of the transportation project of BE550 rigs exported by Loadmaster Universal rigs (Beijing), Inc. from China. The oil drilling rig equipment transport is the key link of the whole oil producing industry supply chain. The significant increase in crude oil price resulted in the rapid increase of demand on the drilling rigs equipment on the market. Therefore, the reasonable analysis, evaluation, selection and implementation on oil drilling rig equipment transportation project have important implications on oil production.

The discussed BE550 rigs have a long term and large amount of supply. To transport the large and heavy rigs in a cost-efficient, timely and reliable way as well as have the safety and quality ensured is a difficult job.

The article first simply introduces and analyzes the BE550 rigs' features and the requirement of the transportation. Secondly, the applicable transport modes are compared and analyzed. The Analytic Hierarchy Process (AHP) principles are adopted, and three criteria and seven indicators are defined to establish a comprehensive evaluation system for the transportation project. The AHP principles are also followed to determine the weights of indicators and to normalize the qualitative indicators. A linear weighting summation method is used to determine the optimal alternative solution of the rig transportation project.

Finally, the article analyzes the cooperation and organization of the rig transportation, and discusses the factors which are important to the smooth operation of the project.

KEYWORDS: BE550 rigs, cost efficiency, timely and reliable delivery, quality and safety, heavy and bulky cargo, transportation, AHP, evaluation system

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LIST OF ABBREVIATIONS

AHP: Analytic Hierarchy Process

BLN: Billion

CBM: Cubic Meters

CTN: Container

DIM: Dimension

DWT: Dead Weight

GIS: Geographical Information System

GPRS: General Packer Radio Service

GPS: Global Positioning System

GSM: Global System for Mobile Communications

GWT: Gross Weight

HEN: Hefei to Nanjin

HH: Huangshi to Huangmei

HN: Nanjin to Shanghai

JIT: Just In Time

KM: Kilo Meter

KN: Kilo Newton

KPI: Key Performance Indicators

KW: Kilo Watt

LM: Loadmaster Universal Rigs (Beijing), Inc.

MCC: Ministry of Communications of People's Republic of China

ML: Million

QTY: Quantity

SJ: SJ Petroleum Machinery Co.

SOR: Shanghai Outer Ring

SWL: Safe Work Load

SWR: Safe Work Reach

YH: Yichang to Huangshi

RESEARCH ON BE550 RIG TRANSPORTATION

1. Introduction

1.1 Introduction of BE550 rigs transportation

The oil drilling rig equipment transport is the key link of the whole oil producing industry supply chain. The significant increase in crude oil price resulted in the rapid increase of demand on the drilling rigs equipment on the market. Therefore, the reasonable analysis, evaluation, selection and implementation on oil drilling rig equipment transportation project have important implications on oil production.

Loadmaster Universal Rigs (Beijing), Inc. (LM) has started manufacturing BE550 drilling rigs at SJ Petroleum Machinery Company (SJ) which is located at Jinzhou City, Hubei Province, China since the beginning of year 2006 and exported BE550 rigs under FOB Inco-term 2000.

This type of rig has a long term and large amount of supply. To put as many rigs as possible into employment and keep the consistency, LM need to transport them in a way of cost-efficiency, timely and reliable delivery as well as ensured quality and safety.

A whole set of BE550 rig equipment has a volume of 891 cubic meters and the gross weight of 227.6 tons. According to the packing standard adopted currently, a set of rig contains 21 packages. Among them, the mast has the largest dimension of L24.50 x W3.60 x H3.05 meters, a volume of 269 cubic meters, and the heaviest cargo is the sub-base, 40 tons.

To transport such cargos of over-size and over-weight is a difficult job. It not only has high demands on technical issues, such as transport equipment and facilities, but also on good cooperation and organization of the parties involved, as the transport concerns many parties' benefits. These challenges are the critical elements need careful consideration for the determination of the transportation project.

1.2 The purpose and significance of the research

The article researches on the rig transportation from SJ yard to Dock 10 of Shanghai Port. The practical rig transport procedure is as follows: a rig is trucked from SJ yard to Shashi barge terminal, loaded on a barge and shipped along the Yangtze River to Dock 10, where it is transferred to a sea ship and exported.

However, the situation of Chinese domestic transport market is far from perfection. Therefore, there are conflicts between the demand of the transportation and the supply of the service on the market. Furthermore, with the increasing trend in Chinese industrial equipment exportation, the industrial equipment transportation is becoming more demanding. Their transportation and the rigs' transport have a lot in common. To transport these large equipments in a satisfactory way becomes an important issue to research.

1.3 Research methods

Author will do on-site survey and a questionnaire to obtain the relevant data and information, and use AHP principles to judge and evaluate the suitable transport project.

1.4 Logic link of the paper

First chapter simply introduces the background of BE550 rig and the requirement of transportation. It is demonstrated that the research is of practical significance for Chinese large equipment transport as the logistics service in China is still at a developing stage.

Chapter 2 reviews researches on the transportation project planning, analyzes and compares the transport modes and markets situation, and discusses the concerned technical issues. The evaluation systems for transportation project decision making, especially the AHP theory, are introduced. And researches on organization management issues are also reviewed.

Chapter 3 gives the details of rigs packing and the simple information of rigs producing procedure.

Chapter 4 analyzes and compares the transport modes and markets situation in details. The road transport and land-water joint transportation projects are selected as optional projects.

Chapter 5 evaluates the road and the land-water joint transportation projects by using the AHP method and principles. Finally the land-water joint transportation project is determined to be the optimal alternative.

Chapter 6 discusses the issues of organizations and cooperation of parties involved as well as the feasible improvement of the performance.

Chapter 7 is the conclusion of the whole paper.

1.5 Limitation of the paper

The paper is completed in a limited time. The author spent rather portion of the time in collecting data and information. But the data are still not as comprehensive and satisfactory as expected.

As the rig production and export is just initialized in China during recent years, there are no such long term and large volume transport projects for rigs before. Thus the wide research on the rig transportation is not found yet in China. Luckily the hydropower stations material supply transportation projects in China are booming and researches on this issue have a great of help for the paper.

The performance of the transportation project is more of practice than of academic theory, the data collected by survey and inquiry are given by the operators and persons in charge. Their evaluation thus is of significance to the paper from the perspective of operation. As the project is a fairly new born thing to all the parties in China, it is more difficult to establish an academic evaluation mode on the practical organization performance, as far as the performance is concerend.

The author is of limited experience in the logistics practice of this project, thus the view is restricted. This paper is only making basic and rough research in this field, further and specialized research should be made to find better solutions for the improvement of the rig transportation in the whole supply chain of oil producing industry.

2 Literature review

2.1 Transportation project planning

In order to develop a reasonable and practical transportation project, people firstly need to have a thorough understanding on the mission (Huang, 2004). The logistics management is the important component of the supply chain management, and the transport is the key practice of the logistics. As one link of the oil producing industry circle, stable transportation and supply of rigs in the long term are elemental to the tremendous demand of the oil industry.

To collect the information related to the transportation is critical to the project. The more relative information for the transportation is mastered, the better can the project meet the demand, and even bring competitiveness for the company (Zhou & Yang, 2004 ,p58-60,159-160). The necessary information covers a wide range, such as total supply volume, periodical supply amount, manufacturing capability and situation, finance, transport equipment and facilities, possible interruption and its factors, traffic conditions, constraints and available market service, etc (Guo, 2003)

For a long term project, the contents and the elements of the transportation are relatively stable, such as personnel and departments in charge, the cargo features, the transport equipment, the transport route, the traffic conditions and the transit time are not subject to frequent changes and fluctuation(Zhou & Yang, 2004, p.58-59). All these factors are the advantages for making a long term transportation project.

When people make the detailed transportation project, they need to have thorough communications with the parties involved, such as the vendor, the vendee, the carrier and the agency, etc. They need to, based on features of the transportation, discuss

the critical factors from all the aspects to make sure that the parties can eventually achieve convergence of views on the project (Guo, 2003; Huang, 2004). The relevant personnel can thus have a full understanding of the project to make sure the key transport performance can meet the demand of the customer, so as to avoid those weak links interfering with the smooth implementation of the project (Lu, 2000).

2.2 The Analysis and Comparison of Several Transport Modes' Characters

2.2.1 Analysis of the railway transport

The railway transport, generally, has features of low transport cost, high capacity, high safety，high continuity and it is suitable for medium or long distance transportation of large amount of cargos. The suitable cargos for the railway transport includes mining products, raw materials or products for heavy industry, manufactured products and agricultural products (Zhou & Yang，2004, p.122-124, p.143).

Railway transport has always been the major force of the comprehensive transport network in China. It generally provides station to station transport service, and rarely provides door-to-door service unless a dedicated line is available, which restricts the service flexibility (Lang, Liu and Huang, 1999). Compared to other transport modes, Chinese railway service has following features: the overall transit time is long, the on-schedule rate is at middle level, the rate of cargo loss and damage ranks at middle to high level (Han, 2003).

As Chinese domestic railway service provider is a monopoly operator, it exposures to competitive pressures from the outside, i.e. other transport modes, instead of the railway system. Obviously in a long time the competition has not been sufficient to

spur its improvement of performance in service. Nowadays, railway transport is under unprecedented pressure of competition, though the absolute railway freight and transportation volume of cargo grows annually. Compared with domestic road transport, it is continually declining in term of the market share (Wu, 2006). The low competitiveness of domestic railway service mainly features: poor timeliness; not standardized charge, and poor awareness of service (Chen, 2004).

As for large cargo transport service, Chinese domestic railway service has problems such as low availability of cargo vehicles, out-of-dated technical equipment, poor-conditioned vehicles, so it can hardly meet the demand of the large cargo transport market (Xiao, 2005).

2.2.2 Analysis of the road transport

The road transport has the greatest advantage that it is the only mode that can achieve seamless transport and the door-to-door service, and the expressway transport is of high cost efficiency (Wu, 2006; Wang, 2006). The road transport also has advantages of more flexibility, lower rate of damage to goods, shorter overall transit time and higher on-schedule rate compared with railway transport (Han, 2003). It is suitable for the transport of minerals, bulk goods, chemical products and containers, etc (Zhou and Yang, 2004, p.143).

But have a look at the domestic road transport situation, we can see the road transport capacity is small, the energy consumption and the cost level are high, the productivity is low, and also it is not suitable for long haul transport for bulk cargo (Zhou and Yang, 2004, p.123). This is partly owing to the fact that the Chinese road transport vehicles are far from specialization and modernization. To meet

demands for modern logistics service, the road transport industry has to develop fast, heavy-load and long-distance transportation in the future (Wu, 2006).

It deserves attention that Chinese domestic road transport industry has a number of issues in the fields of administrative system, enterprises management, infrastructure, technical equipment and environment pollution, leading to irregular competition. (Suo, 2000) The domestic road transport enterprises, no matter of large or small size, in order to pursue short-term interests and maximize their benefits, would all like to take risks to over load cargo seriously and bid down the price in a way of "race to the bottom", finally they are deeply involved in the vicious cycle of the intense competition (Yan, 2000; Zhang, 2000; Niu, 2006).

The impact on the market performance is that the market service appears low cost efficient and unsatisfactory, moreover, there is so far no one leading company can have national influence over this market (Qin, Ye 2005, and Wang, 2006).

2.2.3 Analysis of the water transport

The water transport has the advantages of large transport capacity, low transport cost and environmental resource conservation (Chen, 2002; Fang, 2001), the rate of loss and damage to the cargo is low (Han, 2003). Compared to technical and economic features of road and railway transport, inland water transport has comparative advantage in the area with abundant river resources, where productivity, population density and GDP level per capita are high(Fang, 2001; Jia, 2004).

The Yangtze River shipping market, as the main force of domestic inland water transport market, has irreplaceable cargo source advantage and competitive advantage. Meanwhile the market demand has been increasing, especially for

construction materials and mining materials transport (Huang, 2003 and 2004). Jia Dashan (2004) demonstrated that in the environment of the continuous development of economy and transport technology in China, inland water transport will have more competitive advantages in modern logistics service, and it is the time for Yangtze River shipping industry to play a more important role on domestic transport market. See table 1:

Table 1 The economy statistics of Chinese provinces along the Yangtze River in 2002

Provinces	International Trade Amount	GDP	GDP per square km	GDP per capita	Population Density	Inland water Transport Competitive Advantage
	100 ml USD	1 Bln RMB	100 RMB	100 RMB	People/ km^2	
Shanghai	723	5409	932600	406.46	2761	Achieved
Jiangsu	745	10632	106300	143.91	729	Achieved
Anhui	42	3569	27500	58.17	484	Achieves in 2012
Jiangxi	20	2450	15300	58.29	259	Achieves in 2012
Hubei	45	4975	27700	83.19	330	Achieves in 2007

Source; Calculation based on China Annual Statistics, Jia Dashan, 2002

The drawbacks of the water transport include the slow speed, the long overall transit time, the low flexibility and being subject to impact and constraints of weather conditions and environment (Zhou and Yang, 2004, p.124). Normally it can only provide station to station transport service, and the rate of arrival on schedule is lower than that of road transport. Additionally, a large amount of liquidity is occupied during the long transit time (Han, 2003).

Therefore it is the suitable mode to carry out long distance transport for those large volume, low value, bulk cargos or cargo which is not time-sensitive, such as grain, minerals, machinery and equipment, industrial products and daily consumption goods, containers and so on (Han, 2003; Zhou and Yang, 2004, p.143).

Along with the development of the Chinese market economy and the growth of demand for efficient logistics, the problems accumulated inside the Yangtze River shipping system for years have become more pronounced (Xu, 2000; Huang, 2004). The market is intensely and irregularly competitive. Though the shipping is booming, shipping companies' economy efficiency are still low (Luo and Li , 2006）. There is an urgent need for the Yangtze River shipping industry to change present extensive scale-growth mode to improve the economy efficiency ("Information and Literature of water transport", 2003; Huang, 2004).

2.2.4 Comparison and conclusion of above transport modes

It can be seen from above discussion that railway transport's strengths lie in the long-distance transport of bulk cargo. But its overall transport time is long, the flexibility and the service level are low, thus it becomes uncompetitive in the large cargo transport market. The advantages of road transport include seamless transport, door to door service, flexibility and short transit time. But in the long-distance and the bulky cargo transport, it is at a disadvantage stage. The advantage lies in water transport are: the freight rate is low, the large transport capacity. Its disadvantages are long transit time and poor flexibility.

Zhou Zaiqing and Yang Zhigang (2004, p143) scored the major indicators of above transport modes, graded 1 to 5 as table 2. The lower the mark is, the more competitive the indicator is.

Table 2 Transport modes KPI comprehensive assessment

Transport Mode	Speed	Transport Capacity	Service Frequency	Service Reliability	Service Convenience	Sum up
Railway	3	2	4	3	2	14
Road	2	3	2	2	1	10
Water	4	1	5	4	4	18

Source：Modern Logistics Management, Edition 2004, Zhou Zaiqing, Yang Zhigang

Above indicators reflect the general features of 3 transport modes. Clearly, BE550 rig is suitable for the rail, road and/or water transports from the technical perspective. But from the project perspective, there still exists a gap between the rig transport requirement and service level of domestic heavy and large cargo transport market, as the transport services are still at the developing stage. In such case, further detailed analysis is needed for making decision on the transportation project.

2.3 Analysis of technical issues of Transport

2.3.1 Over-size and over-weight cargo in road transport

The so-called over-size and over-weight cargo concerns the transport of bulky and heavy goods, as the cargo's weight and/or shape are so big that lead to restriction on the transportation from bridges, culverts, bend road or height clearance. According to the "Over-size and over-weight cargo road transport code" issued by the Ministry of Communications of PRC in April 2000, transport vehicles traveling on the highways with any of the following situations, are considered overloaded:

(1) The overall height of the cargo and the vehicle is more than 4 meters, measured from the ground (4.2 meters for container tractors);

(2) The overall length of the cargo and the vehicle is over 18 meters;

(3) The overall width of the cargo and the vehicle is above 2.5 meters;

(4) A single vehicle or a truck with semi-trailer or full trailer that has gross weight over 40 tons; Container tractor has gross weight over 46 tons;
(5) The single axle load is over the regulated value.

At present, for the inter-provincial overloaded transport, the carrier should respectively submit written applications to relative highway transport administrations to apply for pass permissions 30 days in advance of the transport. Also the carrier need to provide information and documents related to cargo and transport routes. Administrations will exam the application and respond in 15 days. They may also survey the selected routes to make out transport plan, bridge strengthening plan and sign the relative agreement with the carrier.

2.3.2 The land-water joint transport solution

The land-water joint transport solution has great significance to the increasing bulky and heavy equipment transport. It can ease the possible damage to roads and bridges (Zhang, 2001; Jiang, 2003). Its major weakness is that the risk exists in transshipment operation, which also increases the cost. And the transshipment location is constrained by the environment. But this still remain a practical solution (Zhang 2001; Zhao, 2003). The important technical issues include operation procedures, cargo loading, cargo support structure, road and bridge enforcement, air barriers removal, prevention of overturning, ship's stability as well as technical requirement on handling and transport equipment. Meanwhile, issues such as traffic restrictions, conditions and constraints of highway and /or waterway, climate impact need to be carefully studied (Xu, 2001; Guo, 2003; and Li, 2005; Xu G.Y., 2006)

2.3.3 Tracking and tracing technology

Very helpfully, modern information technologies such as GPS, GPRS and GIS enable people to track and trace the cargo movement at a low cost, so that the person in charge can make decision effectively and improve the company competitiveness (Zai 2006).

2.4 Transport Project Evaluation and Selection

2.4.1 Analysis of the elements of the transportation

The nature of modern logistics is low cost, high efficiency and satisfactory service (Marlow, 2006). The low-cost requirement means the existing costs not only low, but also stable, predictable, controllable as well as further reducible, which can bring cost advantage to the enterprises; High efficiency requires not only on the transport technology and equipment, but also on reasonable and scheduled organization and coordination which will ensure the smooth operation between interfaces, to save time and reduce procedures; Satisfactory service involves above requirements of cost and efficiency, it also involves requirements at following aspects: the transport is on-schedule, stable, timely and adjustable; to provide continuously and stably adequate transport capacity; to adapt to the changes of transport demand; to ensure the equipment and cargo safety throughout the process; to guarantee the timely pass of the document and information; the reliability and flexibility of organizational management and so on. (Huang, 2004; Shi, 2006; Xu 2006;)

From the safety aspect, the rig manufactory cycle is so long and it involves so many parties' interests that the follow-up impact will be far greater than the loss the rig itself in the event of an accident, such as the problems in accident handling, the huge

handling costs, the customer's business losses, the market opportunities and reputation as well as the damage to the long-term relationship between the parties.

From an economic point of view, as a customer having the negotiating advantage in the highly competitive transportation market, if the customer extremely leverages the market competition in order to obtain the lowest price, it will impact the transport service quality of which he is not expecting (Hitt, Ireland, Hoskisson, 2006). The trade-off exists between the low price and low level service. So the customer has to carefully determine the priorities of them in their decision-making (Xu,2006).

2.4.2 Methods developed for transportation project evaluation and selection

A transport project decision-making needs a comprehensive evaluation for above involved factors which are often in conflict. For the selection of suitable transport project, many researches have been carried out. The Analytic Hierarchy Process (AHP), is a widely used multi-criteria decision making method developed by T. L. Saaty in 1970s, it simplifies a complicated problem by setting up a hierarchical structure to judge the optional projects. It can analyze both quantative and qualitative factors to determine the priorities of all factors systematically and comprehensively. It has proved practical and valid for many fields.

Dou Huijuan, Zhang Xiaodong and Zhang Huili (2002) studied the application of AHP in transportation mode selection, by using AHP principles to analyze issues of the indicators selection, the judgment matrix formation, consistency examination and the weight calculation.

Du Sanlin (2000), Huang Minghui (2004) changed the previous practice that only carries out quantitative analysis on the investment and cost, while for the impact of

other factors on the programme, the analysis is qualitative. They also adopted AHP principles to comprehensively evaluate the transportation project, and finally confirm the project which complies with the actual practice. This further demonstrates that the AHP method is applicable to and valid for transport project selection.

Hu Songpin (2002) compared and analyzed various transport modes, in terms of speed, cost, convenience, capability and safety, then argued the functional relationships among the transport volume, distance, capacity and weight; He advanced 5 basic principles of transport operations and the transport database model, based on which the decision-making mode for the transport project is established.

Chen Xiangdong (2005) developed an optimization model combining the transit path and transport mode decision-making to solve issues of transport network that can be divided into phases. He makes out the solution for an issue of a virtual transport network by converting it to a problem which is equivalent to the original, which aims at the shortest path issue, and. This method proves feasible and effective for the selection of optimal transport route and mode that can meet the requirements of low cost, safety and timely transport.

2.5 Cooperation, coordination and control

2.5.1 Quality system

The successful implementation of the project calls for the establishment of the quality assurance system in advance, including the quality assurance framework, transport organizations, manning and training, document management; preconditions and process control, specific means for quality control implementation and nonconformance correction, etc. (Lu, 2000).

2.5.2 Information sharing

In the process of implementation, supply chain members should share information to shorten the cycle, lower the cost and improve the efficiency. To ensure that the information is fluent in transmission, key members of the whole supply chain should review and re-design the contact procedure if necessary. This will help maintain the value of information by reducing the uncertainty and delay of information (Zeng, 2006).

2.5.3 Team work and cooperation

Cargo transport process relies on the team work, because it requires the involved parties to make full use of their expertise, facilities and other resources. In order to define the responsibility and improve the efficiency of the tem work, a structure needs to be set up in such a way that the cooperation in the entire team can be monitored and controlled. And the supervisor should have the right of "surplus claim" as the encouragement for his positive function in such a structure (Hao, Ma, Zhang, 2006).

2.5.4 Human factor

Last but not least, the team leader should play an active role to command, coordinate and inspire the team, positively control the possible deviations and accidents of the performance, to achieve the organizational goals (Huang, 2000; Shi 2006).

3. Simple introduction of BE550 rigs packing and manufactory

BE550 rig's detailed dimensions and weights after packing are listed in table 3:

Table 3 BE550 rigs packing list

RIG：BE550 Rig		PACKING LIST					
Item	Description	Dimension(cm)			Volume	Qty	GWT
LM1	Mast	24.50	3.60	3.05	269.01	1	35.0
LM2	Mast starting section I	9.70	2.55	2.30	56.89	1	9.0
LM3	Mast starting section II	9.70	2.55	2.30	56.89	1	9.0
LM4	Rotary section	11.72	3.30	1.48	57.24	1	19.0
LM5	Sub-base assy.(DS)	18.30	3.35	1.95	119.54	1	40.0
LM6	Sub-base assy.(ODS)	18.30	3.35	1.95	119.54	1	40.0
LM7	Dolly	12.30	3.20	1.60	62.98	1	16.0
LM8	Racking Board	4.30	3.60	2.35	36.38	1	2.6
LM9	Drawworks assy.	6.00	2.60	2.50	39.00	1	26.8
LM10	Substructure stair assy. I	10.50	1.20	1.25	15.75	1	3.0
LM11	Substructure stair assy. II	10.50	1.20	1.25	15.75	1	3.0
LM12	Raising cylinder I	5.50	0.65	0.65	2.32	1	2.0
LM13	Raising cylinder II	5.50	0.65	0.65	2.32	1	2.0
LM14	Hydraulic wire line reel	2.78	1.41	1.45	5.68	1	1.5
LM15	Wire line	1.60	1.60	1.00	2.56	1	5.0
LM16	Traveling block	1.70	0.70	0.70	0.83	1	2.0
LM17	Walkway for draw-works	4.00	2.20	1.60	14.08	1	2.0
LM18	Iron case I	2.13	1.30	1.02	2.82	1	2.7
LM19	Iron case II	2.13	1.30	1.02	2.82	1	1.0
LM20	Iron case III	2.13	1.30	1.02	2.82	1	1.0
LM21	Iron mesh case	3.00	1.70	1.17	5.97	1	5.0
Total					**891.19**	**21**	**226.5**

Source: LM practical statistics

For the rig's manufactory cycle in SJ yard, see table 4:

Table 4 BE550 rigs manufactory cycle

Item	Manufactory	Testing	Painting	Packing	Loading on Trucks
Time	5 months	15 days	7 days	2 days	1-2 days

Source: LM practical statistics

4 Analysis of the transport projects

4.1 Analysis of the railway transport project

4.1.1 The railway transport market

In theory, rail transport is suitable for long-distance transport of large quantities of goods, and the price is lower than the road transport. According to the Ministry of Railways, the freight of China railway transport in 2005 is 27 million tons, having an increase of 8.2% than that in 2004. Railway cargo transportation volume in 2005 is 2.0734 trillion ton kilometers, increasing 7.5%. However, its market share still declined (Wu, 2006).

For the cargo freight and cargo transportation volume of railway, road and water transportation, see table 5.

Table 5 China domestic railway, road and water cargo transport statistics, 2005

Transport Mode	Cargo Freight （Bln tons）	Market Share (%)	Cargo Transportation （Bln ton* KM ）	Market Share (%)
Railway	2.70	15.12	2,073.40	27.42
Road	13.14	73.57	847.60	11.21
Water	2.02	11.31	4,639.70	61.37
Sum	17.86	100.00	7560.70	100.00

Source: the MCC and the Ministry of Railway statistics, 2005

4.1.1.1 The common service problems of railway transport

The low level service is the weakest competitiveness for domestic railway on the heavy and bulky cargo transport market. Since Chinese railway cargo transport system has been in a monopolistic position for several decades, they have a weak

sense of service and market. The lack of communication and cooperation with other transport systems, the insufficient information sharing network and the un-standardized tariffs and price system which is driven by short-term interests further damage the railway industry's reputation and competitiveness (Lang, Liu and Huang, 1999; Chen, 2004).

Above problems have below features:

(1). The logistics terms and standardized information system are not well established, causing the railway system has difficulty in carrying out inter-regional cooperation and joint operation with other transport systems, thus fail to launch one stop service and door to door transport service (Wu, 2006)

(2). Because of the confusion in development of the logistics management software, the railway logistics warehousing and sorting still rely on manpower, making the service unable to meet customer demand for real-time monitoring, and to change the shipment plan in a timely manner (Lang, Liu and Huang, 1999; Chen, 2004).

4.1.1.2 The problems of railway service for heavy and bulk cargo transport

Most importantly, the railway transport has weak competitiveness in heavy and bulky goods transport markets, the reasons are as follows:

1). The poor timeliness: Because of the complicated application procedures, backward management system as well as technical and operational restrictions on the transport, the total transport time is un-expectable and uncontrollable, the entire procedure may last 4-5 months (Lang, Liu and Huang, 1999).

2). The high freight: Despite the low resumption of the waybill freight, the total freight is too high owing to the un-standardized charges. It is even higher than the road transport freight rates (Chen, 2004).

3). The low availability: The existing railway cars for bulky goods are technically backward, poor conditioned and of low availability, just insufficient to meet market demands (Xiao, 2005).

4.1.2 The railway transportation project

4.1.2.1 The transshipment and time issues

The distance from SJ yard to Wuhan railway station is about 230 kms, rigs need to be trucked there first and then offloaded in the station storage yard, waiting long time before loading.

The railway distance from Wuhan to Shanghai Port Dock 10 is about 1,187 kms, rigs need to be unloaded at the terminal before loading on the sea ship, and additional trucks should be employed to shift the rig to the shipside.

Considering the total transport time and dwell time, the transshipment operations, the uncertain availability of storage yard on both ends and the accompanying inconveniences, it is obviously unable to transport the rig in time and conveniently.

4.1.2.2 The equipment issue

The further disadvantage is that existing railway cars can not accommodate the whole set of rig equipment, the major parts still need road or water transport, which will make the timely delivery more uncertain. For the specifications of the available railway cars, see table 6:

Table 6 specifications of railway cars for cargo transport

Type	Weight (T)	DWT (T）	Capacity (CBM)	Inner Dims (m) (L*W*H）	Max W*H (m)	Door Size (m) (W*H）
Closed Car						
P60	22.20	60.00	120.00	15.5*2.8*2.7	3.3*4.2	1.9*2.6
P61	24.00	60.00	120.00	15.1*2.8*2.8	3.3*4.2	2.9*2.6
P62	24.00	60.00	120.00	15.5*2.8*2.8	3.3*4.2	2.9*2.6
P64	25.40	60.00	117.00	15.5*2.8*2.7	3.3*4.1	2.9*2.6
Open car						
C60	17.20	60.00	67.40	12.9*2.8*1.8	3.2*3.1	1.6*1.7
C61	23.00	61.00	70.18	11.0*2.9*2.2	3.2*3.3	1.2*1
C62A	21.70	60.00	71.60	12.5*2.9*2.0	3.2*3.1	1.6*1.9 1.2*0.9
C65	19.30	60.00	68.80	13.0*2.8*1.9	3.2*3.3	1.6*1.8
C75M	23.00	75.00	75.04	13.4*2.8*2.0	3.2*3.1	1.2*0.95
Flat Car				L*W (m)	(W*H)	
N6	21.50	60.00	35.90	12.50*2.87	3.15*1.878	
N9	22.00	60.00	38.40	13.40*2.87	3.15*1.878	
N15	15.90	65.00	24.51	8.17*3.00	3.166*2.026	
N17	22.30	60.00	38.74	11.30*2.98	3.172*2.015	
Car for heavy and bulky cargo				(L*W)		
D22	41.40	120.00	75.00	25.00*3.00		
D23	104.00	235.00	70.60	28.00*2.52		
D17	50.00	150.00	23.00	10.20*2.00		

Source: China Railway International Freight Agency Co., Ltd

4.1.2.3 The cost issue

The cost issue further weakens the railway transport competitiveness. If the rig can be completely carried by the train, the basic freight amounts about RMB 96,000 as per quotation. But the additional charges, transshipment handling cost, trucking and storage fee will amount another RMB 200,000 as per market situation. The total cost is much higher than that of road or water transport.

Considering the above factors, the railway transport project is cancelled.

4.2 Analysis of the road transportation project

4.2.1 The overview of road transport project features

Road transport has the advantages for such a large equipment shipment, as it can provide a seamless and door-to-door transport service with much shorter transit time, lower cost and more flexibility. However, its disadvantages in long haul and large volume transport partially offset the above advantages. Its instability in transit time caused by the constraints of weather and geographical restriction is another vulnerable point.

4.2.2 Overview of the road transport market

A few problems in Chinese road transport market affect these enterprises' economic benefits and service level. There is no national or regional brand-named and large enterprise in Chinese road transport market, a lot of small and weak trucking companies are struggling in the irregular and competitive market, while they can not cooperate well and organize mutually to archive the economy of scale (Wu, 2006).

4.2.2.1 Market information organization

The services of information organization and distribution are un-standardized, leading to the phenomena that un-laden and seriously overloaded trucks coexist almost in all the companies (Qing and Ye, 2006); In 2003, the average rate of un-laden vehicles on return trip in China was 64%, causing a loss of billions of US dollars (Zhang, 2006).

4.2.2.2 Vehicles technical condition

As for the vehicles' technical condition, the old and the high energy consumption vehicles are more than diesel trucks, heavy load trucks and specialized vehicles. Therefore the average unit productivity and efficiency are low (Wu, 2006).

4.2.2.3 The expressway transport

The wide gap between Chinese expressway transport efficiency and that in Europe and America reflects the above problems. Chinese expressway mileage ranks second in the world, the condition is close to that of America. The average transport mileage of European and American expressway transport industry is about 300 kms, while it is 63 kms in China. Such a performance can not utilize the advantages of expressway at all. Trucks' average speed on American expressway is about 100 km per hour or more, while 60 km per hour in China, even 15 km per hour in the case of serious overloading. It severely affects the timely delivery and causes traffic jams on the expressway (Wu, 2006), which is far from the basic requirement of JIT, the successful mode in logistics field. It also implies a high cost to the consignors which is demonstrated by the fact that the average logistics cost in China is about twice as much as that in the U.S. (Zhang, 2006)

4.2.2.4 The overload and deviation issues

Almost every driver consulted in the survey admits that they have to overload as much as they can so they can make some profit, owing to the low freight, layers of outsourcing and low rate of engagement on return trips. The drivers also admit that they have to stop in the middle way or deviate to take more cargos, which lead to delayed delivery and unreliable transit time. Such overloading and deviation are risky for the rig transport in term of safety and time issues. They will cause potential economic loss (Ma, 2005).

4.2.3 The road transport route

It is confirmed by both inquiry of drivers and measurement, the shortest and best route is to transport on the expressways: From the SJ yard, via 318 State Road, to YH expressway (Yichang to Huangshi via Jinzhou and Wuhan), then to HH expressway (Huangshi to Huangmei), and then to HHE expressway, (Huangmei to Hefei), through HEN expressway (Hefei to Nanjing) to HN expressway (Nanjing to Shanghai), finally via Shanghai Outer Ring Expressway (SOR) exit to the port(Cheng, 2001). Table 7 has the en-routed highways & expressways' statistics.

Table 7 The Statistics of Highway and Expressway rig transport En-routed

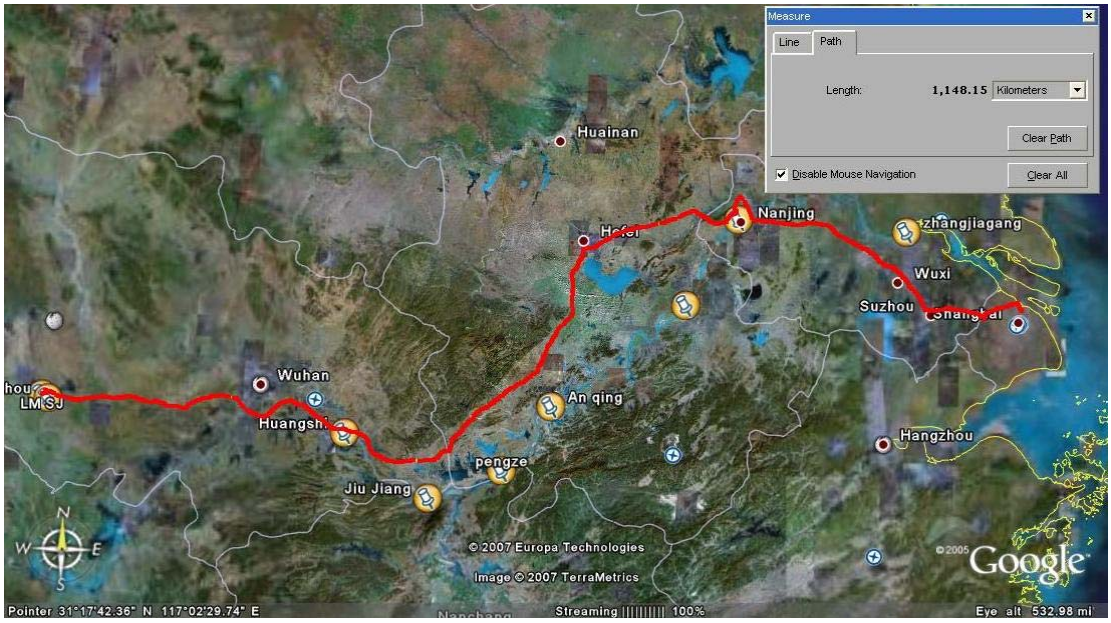
Route	Lane	Width	Length	Road Designed Load	Max speed	Traffic Volume Unit*Time/Day
SJ to YH Expwy	4	6m*2	8 km	Standard State road	40-60 km/h	Not available
YH Expwy	4	9m*2	270 km	Truck 20+，Tractor 120	120 km/h	25400
HH Expwy	4	9m*2	109 km	Truck 20+，Tractor 120	120 km/h	Not available
HHE Expwy	4	8.5m*2	273 km	Truck 20+，Tractor 120	120 km/h	Not available
HEN Expwy	4	8.5-9m*2	169 km	Truck 20+，Tractor 120	120 km/h	26000
HN Expwy	4	10m*2	274 km	Truck 20+，Tractor 120	120 km/h	60000
SOR Expwy	8	50m	37 km	Truck 20+，Tractor 120	80 km/h	40000
SOR Expwy to Dock 10	4-6	9m*2	9 km	Truck 20+，Tractor 120	40-60 km/h	Not available

Source: the MCC branch websites, local Government websites, Google Earth and on site survey

The total expressway mileage is about 1,130 km and 1,148 km for the whole trip. If the average speed of vehicles is 60 kms per hour, as the regulated minimum speed on Chinese expressway, running 14 hours a day, and 40 km per hour on other sections, in theory the rig can reach Shanghai Port in one and a half days.

The detailed route is as figure 1:

Figure 1 BE550 rigs road transport project route



Source: measured on Google Earth

4.2.4 Problems of the road transport project

The project was not adopted as the prime project, though it seems very quick. It is based on following reasons:

4.2.4.1 The freight cost issue

The freight cost amounts 180-220 thousand RMB as per present market situation, which is higher than water transport cost.

4.2.4.2 The heavy and bulky cargo transport issue

Among a whole set of equipment, 9 packages are oversized and 5 are over-weighted. The weight issue: Normally, the major constraining factor on the heavy and bulky cargo transport is the weight. Before the truck pass through the bridge, people must

inspect the actual condition and calculate to see if the bridge need to be strengthened (Jiang, 2003; Chen, 2001). The calculation formula is as below:

U=（K1-K2）/K2 X 100%

K1: overall weight of the vehicle and truck

K2: Bridge designed load or current safe load

If U<=0, allows the truck to safely pass through，

If 0<u<=5%, allows the truck to pass through，

If 5<u<=25%, allows the truck to pass through after strengthening the bridge

If u>=25%, prohibit the truck passing through

Suppose the Shanqi BM294 / F2000 / JS294 or Beijing SRFJB-1H types of full trailer trucks, 6 axels (1 fore, 2 middle and 3 aft) and 22 tyres, are used to transport the rig, the gross weight will reach 46.5 tons to 54.8 tons, the average axel load is less than 130 KN (the designed load of expressway, truck 20+ as per MCC regulation). It is noticed that as per the management regulation of Huangshi Yangtze River Bridge, trucks less than 70 tons can pass through the bridge, the designed load of Shanghai outer ring expressway is 55 tons, and 2 truck cranes of 55 tons each safely passed through the same route from Yichang to Shanghai in April 2006, above facts prove that the weight issue is not the major problem for the rig transportation.

The height issue: The truck loaded with mast is the highest one, it reaches 4.05m, 5 cm more than the value in the regulation, while less than that for the container truck. And the height clearance along the route are all enough for the container truck transportation. Most cable poles, bridge and culverts have clearances above 4.5 meters, so the height issue is not the major problem either.

The length and width issue: The major problem is caused by the length and the width, there are 3 packages have overall length above 18 meters, 9 packages are over width and 6 of them are over 3 meters. They cause a serious of impacts on the transport as follows:

1) The cost loss:

In Hubei, Jiangsu provinces and Shanghai city, they are allowed to run on the expressways, but they must pay some penalty and special charges. The lowest charge is RMB 300. In some case the penalty reaches RMB 7,000 to 8,000, which is an irreparable loss, large enough to offset the trucking company's profit. If the truck is detained for over-size while the delivery deadline is very close, the trucking company will have to pay RMB 3000 as special penalty to temporarily release the truck so as to ensure the cargo can be delivered in time, because the penalty of missing the ship is terribly high. As the administration is un-standardized, some additional cost must be expensed to ensure the rig can go ahead when certain trouble arises. These factors increase the cost while reduce the cost controllability and stability.

2) The prolonging and the unreliability of the transit time:

Sometimes the truck has to be escorted by police cars; the speed is restricted below 40 km/h. It increases the cost and the transit time, also the transit time is not stable and ensured.

The even worse thing is that in Anhui Province, such over-size cargos are often rejected to run on the expressway. In such case the truck has to go to the 105 state road from the Huangmei service area of HH expressway, and go to 318 state road at Qianshan station, cross the Yangtze River at Anqing, then go to 205 state road at

Nanlin, down to Nanjin city, finally run on HN expressway. The truck will additionally run about another 120 km.

The truck's average speed on the state road is much lower than that on the express way. The width of state road in Anhui is about 5 to 6 meters, which normally restricts the truck with rig to overtake other trucks. It also restricts other trucks to overtake it. Thus the possibility of being stopped or detained by policeman increases significantly.

To avoid the peak time, or to make up the economy loss or make more profit, or to avoid detain, sometimes drivers will have to deviate, or stop in the middle way, or sleep in the daytime and drive in the night time, which will impact the rig safety greatly (Ma, 2005).

These factors which will increase the transit time while decrease the transit time reliability significantly. Upon inquiries of drivers, normally the transit time is about 3 days, which is 2 times as much as that under ideal condition. If the detain or deviation or stopping issues are concerned, the transit time can easily reach 4 days.

4.2.5 The delivery time control and cost issues

Another factor need consideration is the control of delivery time. Shanghai port is so busy that dock 10 can provide storage places for rigs for a long time. Normally they only allow rigs to be offloaded 1 or 2 days in advance of the loading. If the rig arrives earlier and has to stay on the trucks, then the demurrage fee will be charged after 12 hours since its arrival. The daily demurrage fee will at least reach RMB 8800 in case of 11 trucks and RMB 800 for each truck. If the storage yard is available, the daily basic storage fee amount about RMB 360 for each set of rig,

based on current basic storage tariff. And the unloading fee will cost another RMB 30,000 for each handling. Moreover, the port normally arrange unloading in the morning only, if the truck arrives in the afternoon, most probably the driver will have to wait to next work day morning. The unloaded rig will be loaded on other trucks again when they are to be loaded on board a sea ship, which will again cost a lot of money.

The best situation is that all trucks arrives one day before loading, thus the unloading, storage and demurrage issues can be avoided, and sufficient time allowance is available for making cargo survey and problem resolving. But this is rarely achievable. Reasons are given below:

Firstly, the transit period is about 7 days from the time of planning to load trucks to the delivery, if all things go smoothly, the interval of the departure time of the first and the last truck is about 1 day or longer if the weather is bad. Large packages and small packages have different transport routes and speed, causing different transit time. A simple solution for this problem is to employ large trucks and consolidate the large and the small cargos, so the number of trucks will be less, and the transit time difference will be decreased. But it is not a radical solution for the time delivery issue, owing to the basic problem caused by the size and weight of cargos in the transport as discussed above.

Secondly, the ship's schedule is variable due to factors such as port congestion, port call sequence adjustment, accidents, the restrictions of tide, weather and channel etc, which is beyond trucking companies' control. As per historical statistics since July 2006 to May 2007, the rate of change berthing plan reaches 39.29% of all the calls. Please refer to table 8 for the statistics details.

Table 8 Statistics of ships delay

Percentage of calls delayed less than 12 hours	16.07%
Percentage of calls delayed 12-48 hours	16.07%
Percentage of calls delayed over 48 hours	7.14%
Percentage of calls on schedule	60.72%
Percentage of time delayed less than 12 hours	7.83%
Percentage of time delayed 12-48 hours	20.87%
Percentage of time delayed over 48 hours	71.30%
Average of delayed time of each delay	24.6 hours
Range of delays	less than 12 hours to 20 days

Source: Collected data of historical statistics of practice

It is clear that, among all delays, 71% of the delayed time is owing to 7% of ships delay, another 21% of the delayed time is from 16% of ships delay, the rest 16% delay will cause 8% of the total loss of time. Based on above statistics, if the rigs are transported by trucks, most of which must arrive more than 24 hours in advance to make sure the rig is ready before the ship's arrival, thus their wide ranged and unstable delivery time will cause more loss on the demurrage, as the demurrage fee is charged after 12 hours of trucks arrival.

Considering the above factors, the road transport projected was not selected as the prime project.

4.3 Analysis of the land-water joint transport project

4.3.1 Overview of the land-water transport procedure

Currently the rig transport is transported jointly by the road and the water transport. For the transport procedure, see the table 9,

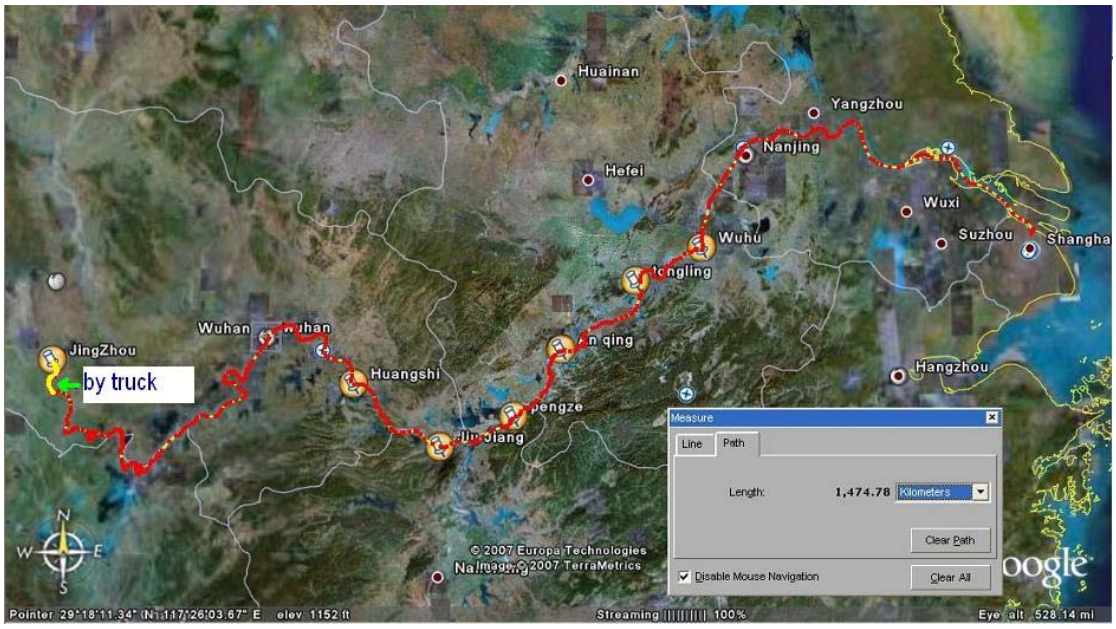
Table 9 BE550 rigs land-water joint transport project procedure

Item	From SJ to Shashi Barge Dock by truck	Shashi Barge Dock to Shanghai Port Dock 10	Transfer to Sea Ship	Free of Demurrage Days
Time	0.5-1 day	5 days	1-2 days	4 days

Source: LM practical statistics

The land-water joint transport project route details is as figure 2

Figure 2 BE550 rigs land-water joint transport project route



Source: measured on Google Earth

The particulars of the barges are listed in table 10,

Table 10 The barges' particulars

Barge type	Open hold barge	Number	6
Build Time	01. 2003 -08. 2005	Class society	CCS
Navigation Area	A，B，C，J2	Dead Weight	1500 ton
Gross Tonnage	983	Net Tonnage	550
Main Engine Power	510 kw	Manning	7
Navigation Duration	340 hours	Max speed	10 km/h
Cargo Hold Dimensions	L39.00，W9.10，H4.85	LOA	70.10 m
Hatch Height	1.20m	Hold Capacity	1721.27 CBM
Module Width	11.60m	Module Depth	4.15m
Light Ship Weight	516.70 ton	Displacement	2163.72 ton
Light Ship Draft	0.80m	Max draft	3.55m
Free Board	A：600 mm, B/C/J2：500 mm	Max height	8.70m

Source: Quancheng Logistics Company

The rig's volume is about 52% of the hold capacity of the barge, if the broken space factor is taken into consideration, the rig will take about 70% of the hold capacity. The mast is not to be loaded on or under any other cargo as it is the critical component. The sub-base, draw-works and the rotary section are heavy cargos and must be stowed on the hold bottom. All cargos should be stowed in such a way that the barge has appropriate drafts fore and aft, no list to either side and the load on the hold bottom is with the designed safe load. (Li and Xiao, 2005)

Normally the drafts after loading are about 0.8 meters fore and 1.7 meters aft, the mean draft is 1.25 meters. The height of the stowed equipment is about 70%-75% of the cargo hold. The gravity center of the cargo is about 1.02 meters above the hold bottom, far lower than the hold center, which is 2.08 meters high. Such stowage can satisfy the requirement of the regulation on the stability of cargo ships in inland water area A which is issued by China Ship Bureau in 1999.

4.3.2 Analysis of the advantages of the land-water joint transportation project

The land-water joint transport is suitable for heavy and bulky cargo transport, it can achieve high level of safety, release the volume pressure on the road transport, make full use of the advantages of 2 transport modes to increase the efficiency and reduce the cost(Zhang, 2001; Zhao, 2003). It proves true in the practice that the land-water joint transportation project has obvious advantages.

(1) First, the SJ yard is close to the Yangtze River and 40 kms away from Shashi barge terminal. The highway has good condition and no restriction for rigs' road transport. It is assured that one heavy laden truck can arrive at the terminal in 2 hours.

(2) Secondly, the Yangtze River has good navigational condition, the distance from Shashi barge terminal to Dock 10 of Shanghai port is about 1435 kms. Along the river，from Yibin to Wuhan, the channel is 24 hours open for ships with displacement less than 5000 tons. From Wuhan to Nanjin, ships with displacement of 5000 tons are allowed to sail all the time. From Nanjin to Shanghai, the river is navigable for ships with displacement of 25000 to 50000 tons (Huang, 2004; MCC website).

(3) Thirdly, the cost is low, amounting about RMB 120,000 to 150,000，and the favorable terms of non-demurrage in first 4 days after arrival can reduce the cost risk greatly.

(4) The forth thing is that it is convenient to load and transport the rig on the barge, as it has enough capacity and no restriction on the rig's dimensions；Also the barge can directly get alongside of the sea ship to transfer the rig (The sea ship's crane should meet at least below requirement: the SWL >= 40 tons, the SWR >=1/2 ship's width + Barge hold's width). The transport is easy to control, while the problems of unloading, storage and trucking again the rig to shipside are avoided. These advantages save a lot of time and cost.

(5) Fifthly, the transit time is stable. According to the practical statistics, it takes 6 days for the whole transport to accomplish, if no unexpected incident occurs. The timely delivery can be ensured given sufficient time allowance.

(6) The sixth is that the transport safety and quality are at high level as per statistics of the practice. No accident or damage happened to the rig during one year's operation, no detain or penalty happened to barges, either.

(7) Last but not least, the Yangtze River shipping market develops fast, it has tremendous potential of providing modern logistics service (Fang, 2001; Jia, 2004). There are about 50 well established ports along the Yangtze River, cargo operation facilities, ware houses, storage yards and transport system are comprehensive and still improving stably. The information system development is also in progress (Huang, 2003 and 2004). These conditions can secure the act in emergency for rig transport. The Yangtze River cargo freight and transportation volume statistics in years 2001 to 2006 are as table 11.

Table 11 the Yangtze River cargo freight and transportation volume statistics 2001-2006

Year	Cargo Freight (ml tons)	Percentage of domestic waterway cargo freight	Cargo transportation volume (Bln tons kms)	Percentage of domestic waterway cargo transportation
2001	310	23.36%	84.73	3.26%
2002	300	21.13%	79.53	2.90%
2003	339	21.44%	83.03	2.89%
2004	357	19.05%	120.04	2.90%
2005	421	19.17%	148.45	2.99%
2006	460	18.50%	167.59	3.02%

Source: MCC statistics in 2001-2006

4.3.3 Analysis of the disadvantages of the land-water joint transportation project

On the other hand, the Yangtze River shipping market is competitive, which is supported by the favorable term for the demurrage issue. While the shipping companies have relatively low levels of economy efficiency and profit, this may affect the service quality.

The water transport has also disadvantages of long transit time, which is about twice as much as that of the road transport. It is subject to the constraints of weather condition, such as typhoon in summer season, fog or strong wind in winter season.

After the rig is loaded on the barge, it is difficult to transfer the rig without proper heavy load cargo operation equipment and facilities (Xu, 2006). If accidents happen to the barge, the rig may be subject to serious delay, damage or even total loss, causing serious consequent impact on the supply chain. Thus the vulnerability is always there. As far as the handling of the accident is concerned, the procedure and cost will be a series of huge problems that cannot be over described (Liu, 2003). These factors must be taken into consideration in making the transport project.

4.3.4 Analysis of the Yangtze River navigable channel condition

The restriction factor of the water channel is a critical factor for the rig's water transportation project. There are several shoals along the river, such as shoals near Wuhan Bridge, Taipingkou, Nanmenzhou, Daijiazhou and etc. The drought period in winter season has a great impact on the channel depth.

In August to November of 2006, the Hubei and Jiangxi sectors along the Yangtze River had the lowest level in the corresponding period in history for 4 consecutive months. In the Taipingkou sector, the channel from Yaodianzi to Xiaojizi decreased greatly, the minimum width of navigable channel was down to 100 meters, so that the Yangtze River Shipping Administration Bureau had to re-channel from KM 486 to KM 495 of the midstream since 20th, August, 2006.

Again, in January 2007, the Yangtze River had rare historical low water from Jiangxi sector to Nanjin sector, Wuhu and Nanjin saw annual lowest low water in the

corresponding period in history. The traffic conditions of some fairways deteriorated. Several ships had grounding accidents in the midstream. Anyway, as the Yangtze River Shipping Administration strengthened the traffic control, the smooth traffic condition was ensured eventually.

This proves that the water channel restriction factor needs very serious consideration. According to statistics of the Yangtze River Shipping Administration Bureau, most shoals have depth that over 2.9 meters at least in the low water season. The barge's navigation will not be constrained as its max draft is 1.7 meters. And during the floods time, there is no too much impact and constraint on the barge's navigation capability, there was traffic control only in 1998 during the devastating floods. In conclusion, the barge's navigable probability is very high as far as the channel condition is concerned.

For the depths of main shoals of middle and low reaches of Yangtze River in Jan, 2007, please see table 12

Table 12 Depths of main shoals of middle and low reaches of the Yangtze River in Jan, 2007

Shoal Location	Navigable Channel Depth(m)	Navigable Channel Width(m)	Shoal Location	Navigable Channel Depth(m)	Navigable Channel Width(m)
Jiangkou	3.0	90	Taipingkou	2.9	80
Ouchikou	3.0	120	Chibakou	3.0	110
Daijiazhou	4.3	130	Nanmenzhou	4.3	180

source：The Yangtze River Shipping Administration Bureau

The maintained channel depths of the middle and lower reaches of the Yangtze River in January 2007, see table 13

Table 13 The maintained channel depths of middle & lower reaches of the Yangtze River, Jan. 2007

The navigable channel Sectors	Depth (m)
Yichang --- Chenglinji	2.9
Chenglinji---Wuhan Bridge	3.2
Wuhan bridge---Huanhekou	4.0
Huanhekou--- Wuhu Bridge	5.0
Wuhu Bridge---Yanzhiji	6.5
Yanzhiji---Ebizui	10.5
Ebizui---Liuhekou	10.5

source：The Yangtze River Shipping Administration Bureau

4.3.5 Operational issues

The barge normally arrives at the port before the sea ship's berth time. It needs to shift to the ship side from the berth or the anchorage. Sometimes there will be some unexpected situations. For example, as the Dock 10 wharf is laid in directions of East and West, during the winter time, the north wind is strong and will push the barge against the wharf. The lightly laden barge has a large amount of area above the surface. In such case, it will be difficult for the barge to un-berth and shift to the ship side without assistance, if the wind is over force 5-6. Accordingly, the ship's loading operation is subject to cease. In some other cases, if there are some other barges or bunker barge get along side the ship, the cargo transfer will also be impacted or delayed.

4.4 Conclusion

Comprehensively, according to the experience of rig transport operation, the land-water joint transport project has advantages of low cost, high safety and convenience in organization and operation over other two transport modes. It is reasonably became the prime option for the rig transportation project.

5 The comprehensive evaluation system of rig transportation project

5.1 Analysis of the decisive factors

On the basis of the study of the domestic large equipment's transportation projects, and with reference to the researches done by Du Sanlin(2000), Dou Huijuan(2002) and Huang Minghui (2004), the author investigated the rig transportation cost, distance, time, capability, reliability, quality and etc. It is clear that the transportation project should be practical and fulfill the requirements of **economy**, the **reliability of timely delivery** as well as the **safety and quality**. According to the general principles of AHP, above three requirements are defined as criteria of the evaluation system for BE550 rigs transportation project.

5.1.1 Definition of the criteria

1) Economy: the total operational costs of each transportation project. It consists of main transport cost and possible auxiliary operation cost.
2) Reliability of timely delivery: the ability to ensure the timely delivery is decided by the transit time and its stability.
3) Safety and Quality: the cargo transport safety, quality, capability and constraint as well as the flexibility..

Above contents reflect the general purpose of the rig transport project, also indicates the conflicts among the value judgment for each requirement of the project. Meanwhile it also includes the feasibility evaluation for project.

5.1.2 The comprehensive evaluation system

Based on above discuss, the comprehensive evaluation system of rig transportation project is established as below table 14.

Hierarchy A is the general purpose of the transportation project.

Hierarchy B contains the decisive factors critical to the project.

Hierarchy C contains the indicators of the performance corresponding to the criteria.

Table 14 The AHP comprehensive evaluation system of the rig transportation

Hierarchy A	Hierarchy B	Hierarchy C
A Comprehensive Evaluation System of BE550 Rigs Transportation Project	B1 Economy	C1 main transport cost
		C2 possible auxiliary operation cost
	B2 Reliability of timely delivery	C3 transit time
		C4 transit time's reliability
	B3 Safety and Quality	C5 transport safety and quality
		C6 transport capability and constraint
		C7 transport flexibility

5.1.3 Evaluation Method

(1). Establish the AHP comprehensive evaluation system for the rig transport project.

(2). Compare all the elements by using AHP principles and establish the judgment matrixes

(3). Calculate the priorities value (weights) of criteria and indicators compared to the general purpose.

(4). Normalize the qualitative and the quantitative indicators based on questionnaire and survey results.

(5). Linearly weight the normalized values of indicators and sum them up to determine the optimal solution.

5.1.4 Definition the weight criteria and indicators

The weights are defined as per AHP principle.

5.1.4.1 Pairwise comparison judgment matrix A-B:

Compared to the general purpose of "Comprehensive Evaluation System of Rig Transportation project", the pairwise comparison judgment matrix for criteria is set up as follows：

A	B1	B2	B3	W
B1	a11	a12	a13	Wb1
B2	a21	a22	a23	Wb2
B3	a31	a32	a33	Wb3

Calculate out the judgment matrix's maximum eigenvalue λmax and corresponding eigenvector W= (ωb1, ωb2, ωb3). Define the criteria weight ratio of priority compared to the general purpose.

5.1.4.2 Pairwise comparison judgment matrix B-C

To establish the pairwise comparison judgment matrix for criteria (B) and indicators(C), calculate the maximum eigenvalue and corresponding eigenvector, the judgment matrix B1-C for criterion (B1) and indicators (C) is set up as below:

B1	C1	C2	W
C1	B11	b12	W1
C2	B21	b22	W2

The judgment matrix B2-C for criterion (B2) and indicators (C) is as below：

B2	C3	C4	W
C3	C33	c34	W3
C4	C43	c44	W4

The judgment matrix B3-C for criterion (B3) and indicators (C) is as below:

B3	C5	C6	C7	W
C5	D55	d56	d57	W5
C6	D65	d66	D67	W6
C7	D75	d76	D77	W7

5.1.4.3 Pairwise comparison judgment matrix A-C

To define relative weights of the whole indicators (C) compared to the general purpose (A), it equals to compare the hierarchy of all the indicators (C) to the hierarchy of all the criteria (B), thus we can get the relative weights of the indicators compared to the general purpose of the rigs transportation project.

The pairwise comparison judgment matrix A-C is thus set up as follows, :

C	B1	B2	B3	level C
	Wb1	Wb2	Wb3	gross weight W
C1	W1	0	0	Wb1.W1
C2	W2	0	0	Wb1.W2
C3	0	W3	0	Wb2.W3
C4	0	W4	0	Wb2.W4
C5	0	0	W5	Wb2.W5
C6	0	0	W6	Wb3.W6
C7	0	0	W7	Wb3.W7

5.1.4.4 Normalization of the quantative indicators,

It is difficult to compare the indicators unless they are normalized. All the values of the indicators should be in the value field of [0,1] by the normalization for comparison.

For the evaluation indicator ui∈U, let its value field be di=(mi,Mi). “mi” and “Mi” mean the minimum and maximum values of the evaluation indicator Ui respectively.

Define: ri=Udi(x) i=1,2,…,n

The cost indicators can be normalized as per below formula:

$$ri=Udi(x)=\begin{cases} 1 & Xi<=mi \\ (Mi-xi)/(Mi-mi) & Xi\in di \\ 0 & xi>=Mi \end{cases}$$

5.1.4.5 Normalization of qualitative indicators

The qualitative indicators can be normalized by setting up pairwise comparison judgment matrix to get the priorities of each indicator, and examine the consistency as below:

Ci	P1	P2	Wj
P1	e11	e12	W1
P2	e21	e22	W2

5.1.4.6 Linearly weight the judgment matrix and then sum up the value, the maximum value demonstrate the best alternative.

It is noted eigenvector W3=(w31,w32,……w3m)T, normalized matrix R=(rij)nxm,

Then the value of Project $_i$, Ui=∑Wi*rij

The best alternative project satisfies: MaxUi：a∈A, A is the collection of all available projects.

5.2 Evaluation of the indicators of the transportation projects

As per the survey result based on consulting and questionnaires of the professional personnel, the marks for the indicators for the road transport project (1) and the land-water transport project (2) are as shown in table 15. Among them the indicators are classified to 7 grades instead of 9 grades to make the evaluation of survey simple. The larger mark the indicator has, the better the performance of the indicators is.

Table 15 Mark of the indicators as per survey result

Project	C1(1000 RMB)	C2(1000 RMB)	C3(day)	C4	C5	C6	C7
1	200	50	3	4	5	3	6
2	135	30	5	6	6	6	5

5.3 Define the weights

5.3.1 Define the weights of criteria

The pairwise comparison judgment matrix for the weights of criteria compared to the general purpose of the project is as below：

A	B1	B2	B3	W
B1	1.00	1.00	0.50	0.25
B2	1.00	1.00	0.50	0.25
B3	2.00	2.00	1.00	0.50

Maximum eigenvalue is λmax=3

The corresponding eigenvector is W=（ωb1,ωb2,ωb3）T =(0.55,0.21,0.24)T ,

5.3.2 Define the weights of indicators compared to criteria

The criterion of Economy (B1) and indicators (C1-C2) pairwise comparison judgment matrix B1-C as below:

B1	C1	C2	W
C1	1	3	0.75
C2	1/3	1	0.25

Maximum eigenvalue is λmax=∞

The criterion of reliability of timely delivery (B2) and indicators (C3-C4) pairwise comparison judgment matrix B2-C is as below:

B2	C3	C4	W
C3	1.00	0.50	0.33
C4	2.00	1.00	0.67

λmax=∞

The criterion of safety and quality (B3) and indicators (C5-C7) pairwise comparison judgment matrix B3- C is as below:

B3	C5	C6	C7	W
C5	1.00	3.00	2.00	0.55
C6	0.33	1.00	1.50	0.24
C7	0.50	0.67	1.00	0.21

λmax=3.07

The above results are all of consistency subject to examination.

5.3.3 Define the weights of indicators (C) compared to general purpose (A)

The relative weights of the indicators in the index hierarchy compared to the whole criteria hierarchy are calculated as below:

C	B1	B2	B3	Hierarchy C weight W
	0.25	0.25	0.5	
C1	0.75	0	0	0.19
C2	0.25	0	0	0.06
C3	0	0.33	0	0.08
C4	0	0.67	0	0.17
C5	0	0	0.55	0.28
C6	0	0	0.24	0.12
C7	0	0	0.21	0.11

We note：

The weights of the criteria are(0.25(B1), 0.25(B2), 0.50(B3))

The weights of the indicators are (0.19(C1), 0.06(C2), 0.08(C3), 0.17(C), 0.28(C5), 0.12(C6), 0.11(C7))

5.4 The normalization of the criteria

5.4.1 The normalization of cost indicators

Indicators C1，C2 and C3 are normalized as per below formula:

$$Ri=Udi(x)=\begin{cases} 1 & xi<=mi \\ (Mi-xi)/(Mi-mi) & xi \in di \\ 0 & xi>=Mi \end{cases}$$

We can get the results of normalized satisfaction value corresponding to the indicators as below:

Project	C1	C2	C3
1	0.20	0.17	0.86
2	0.85	0.50	0.29

5.4.2 The normalization of qualitative indicators

The normalization is as below

C4	1	2	W
1	1	0.67	0.40
2	1.50	1	0.60

λmax=∞

C5	1	2	W
1	1	0.83	0.45
2	1.20	1	0.55

λmax=∞

C6	1	2	W
1	1	0.50	0.33
2	2.00	1	0.67

λmax=∞

C7	1	2	W
1	1	1.20	0.55
2	0.83	1	0.45

λmax=∞

Above data are all consistent.

5.5 Linearly weight the indicators and sum up

To linearly weight the indicators and sum up the value to determine the best alternative project, After the normalization of the above 7 indicators, we can get:

$$R=\begin{Bmatrix} 0.16 & 0.14 & 0.70 & 0.40 & 0.45 & 0.33 & 0.55 \\ 0.52 & 0.30 & 0.18 & 0.60 & 0.55 & 0.67 & 0.45 \end{Bmatrix}$$

W=(0.19, 0.06, 0.08, 0.17, 0.28, 0.12, 0.11)T

W3 =R * W =(0.39，0.52)T

The land-water joint transport project has higher mark than road transport project; this result is in compliance with the fact, proving the model is practical and valid.

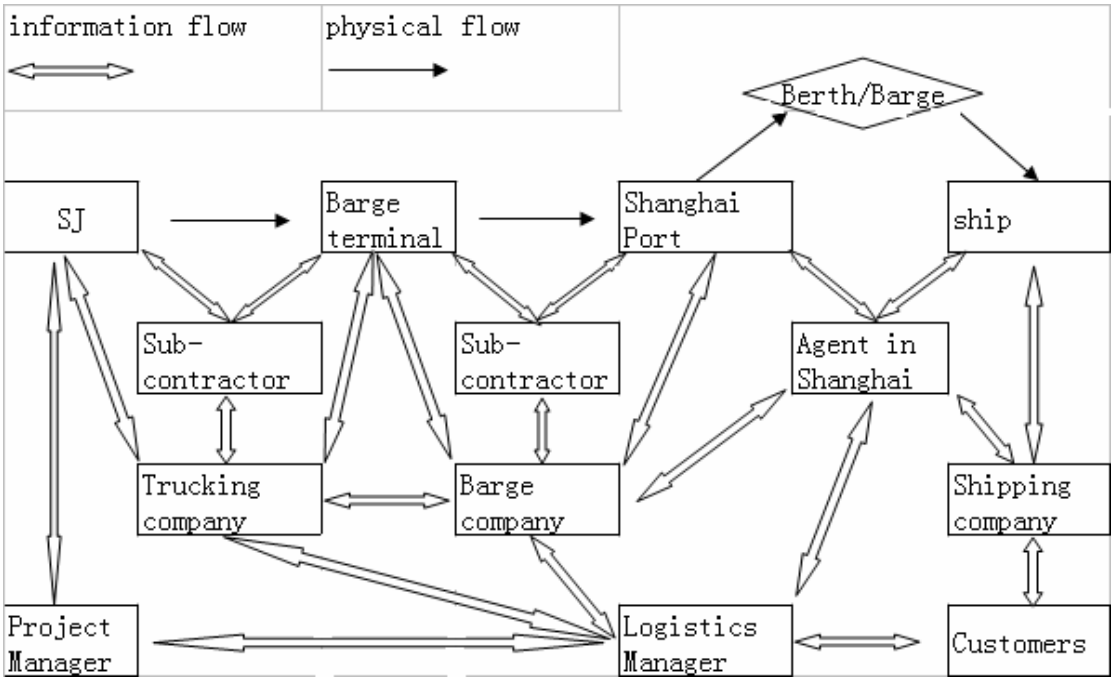
Surely, as the rig transport is implicated in a lot of factors, the probability of emergency arising is high, LM still need to take road transport project as emergency measures for the commission of rig transport.

6 The transportation organization and coordination

6.1 Profile of the transportation organization and cooperation.

The profile of the rig transport operation procedure, organization and cooperation are as figure 3

Figure 3: BE550 rigs transport procedure and organization



Source: summarized based on the practice

Currently, the customers of LM book the ship under FOB Incoterm 2000, based on the continually updated rig delivery schedule and ship's schedule. Normally it is about 3 weeks before the ships arrival, i.e. at the time when the rig is in test. Then the customer will notice LM.

The LM project manager will coordinate with SJ to make sure the rig will be completed in time. LM logistics manager will keep frequent enough contact with

the project manager and the customer so both sides are aware of status of the rig and the ship. He needs to provide the packing list to the customer 1 or 2 weeks in advance for the shipping company making out the stowage plan.

At the same time LM logistics manager books truck and barge as per the final delivery schedule determined by both LM and the customer. The trucking company and the barge company will contact their sub-contractors in some cases, or they will arrange their own equipment to fulfill the commission, they will be responsible for their technical operation at SJ yard, Shashi Barge terminal and Shanghai Port.

The agency working for LM in Shanghai will be in charge of the material receipt of cargo, customs clearance and rig's loading on board the ship.

6.2 Overview of the performance

However, in the practice, because the capability of the factory and the weather constraints on production, the production schedule fluctuates frequently, and the ship schedule varies also, it is not few to see that the barge arrives much earlier than the ship or arrives "just in time". Thus a few of heart attacking emergency situations occurred, which almost interrupt the smooth operation of the transport project.

At the same time LM suffer the economy loss. From the view of the supply chain, parties involved need to enforce their organization and cooperation so that the rigs can be transported in an economic, timely, reliable, and safe and qualified way.

6.3 Transport service contractor selection and evaluation

Both the value and the volume the BE550 rigs are very high, obviously LM has to find some reliable and qualified carriers to transport the rigs consistently in a long term, instead of playing with different companies in a way of case by case.

To fulfill the mission, LM should first develop standards and technical specifications of the transport on the basis of the technical characteristics of rig to set standardized transport operation procedure, as the basic requirement of the transport.

Before they sign the contract with the carrier, they should carefully investigate those candidates from aspects such as technical equipment, human resource, finance, organization, service system, company culture, to see if they are qualified and capable to provide services as required, as well as their attitudes and willingness in the future in cooperation (Jespersen & Larsen, 2005, p.23; Shi 2006; Xu, 2006;)

Both carrier and LM need to set up a system for regular review and scrutiny on the key performance. So that they can analyze the non conformance and accidents and take precautions against those accidents, amend the operation technical regulations and organization system and improve the whole performance(Lu, 2000, Yang and Zhou, 2004, p.60, 70, 73-76).

6.4 Responsibility clarification and mutual understanding

Parties involved need to understand that the economy loss caused by the time factor is an assignable burden to each party. They need to clarify the responsibility in the case of loss.

But mutual understanding and compromising are more important, from the view of long term cooperation and supply chain, because such loss are beyond each side control. Such a policy can assure the contracted carrier provide good service at a reasonable level of profit, and the transport cost of LM will be relative stable and controllable(Shi, 2006; Jespersen & Larsen, 2005, p.151).

6.5 Information management

The information flow is more important than physical flow for the supply chain operation, and more important, if any link in the supply chain fails, it will cause disorder to the whole supply chain (Muller, 2006). Modern logistics rely much on the time control. (Jespersen & Larsen, 2005, p.26)

Undoubtedly, to deliver the rig in time, all the parties involved should actively communicate and coordinate with each other, providing proper information. The logistics manager plays an impotent role functioning as an information sharing point, to collect and distribute information efficiently and effectively. The other parties should correspond with routine and special information in time (Fu, 2006).

It is worthy of mentioning that as the direct operator, the carrier should be well noticed in sufficient time that they can make out the plan, prepare the proper and adequate equipment and facilities to carry out transport seamlessly.

Nevertheless, during the transportation, the trucks' and the barges' trace can be collected by making use of the information technology, such as GPS, GPRS, GSM and GIS, keeping both LM and carriers posted of the rig's status(Zai, 2006).

6.6 The coordination of the parties

It is important for parties to coordinate to understand other parties' demand and the actual problems in the transport operation, so as to design a set of procedure and regulations that ensures the seamless transport. Otherwise there will be endless problems.

For examples: Currently, all the small packages have only lift points but no pallets for the fork lift as they are lifted by crane. But when the cargos are stowed in the ship's hold, sometime stevedores need to adjust them by fork lift. This drawback on design makes problems to stevedores;

Sometimes irresponsible workers in SJ put wrong shipping marks on the package or won't to pack the equipment as required, causing the shipping mark description and amount of packages are different from those on the packing list. The huge risk arises in such case as the tally company will not allow such cargo loaded on board.

Sometimes the packages are of different dimensions from the packing list, due to the workers change the packing as they please or for their convenience, such case leads to the risk that the cargos can not be loaded as per stowage plan, in serious situation, the cargo may even be rejected by the ship.

And sometimes, the small pieces of cargos are stowed below the mast to save space in the barge hold, but when the cargos are shifted to the sea ship, stevedores have to move the huge mast away, take up the small packages, and restore the mast. This will increase the operation time and risk of the mast.

These phenomena strongly show the communication and coordination are critical to the rig transportation. The team leader should monitor the performance effectively and strictly, so as to make sure his team will not be the weakest link of the whole chain (Huang, 2000).

6.7 Containerization and its benefits

There's another point that worth mentioning is the sharing in container purchasing cost will bring benefits to both LM and their customers. The rig can be partially transported in container. On the basis of current packing standard, it is possible to decrease the volume of small packages to around 65 cubic meters and consolidate them in two containers (one 20' CTN. & one 40' CTN.).

There are significant benefits in using self-owned container:
Firstly, it brings low cost. Being compared with bulk cargo, half of the transportation cost could be saved. Meanwhile LM can save the cost in packing if the second-hand container is used.

Secondly, the safety of the cargo could be improved, as the equipment is more protected and the loading /unloading operations are simplified.

Thirdly, the cargo handling time could be dramatically reduced that brings profits to LM, trucking company, shipping company and other parties involved.

Last but not least, a container is not only an efficient transportation box for cargo handling, but also a multi-usage storage area for oil-field operation.

Thus, motivating containerized transportation is a way of improvement that benefits multi-lateral parties.

6.8 The financial issue

However, it is interesting that even if the rig is transported to the ship side in time, there are still risks in submission.

In theory, LM's customer will only pay LM after the receipt of the rig, but it is not always true. The reason is that it takes several work days to transfer the money from overseas customer's bank account through LM to SJ's bank account. To make up for the transaction time, the overseas consignee had to pay LM before the receipt of the rig. Then LM can have sufficient to transfer the liquidity to SJ. In case of the failure of doing so, SJ won't release the rig, even the rig is 10 meters away from the ship, unless some urgent and special measures are taken. Only in such a way can the customer avoid late delivery of the rig and the dead freight charged by the sipping company.

If the prompt payment is not realized and rig is detained, that will lead to longer time and more cost in leaving the rig on the barge or the storage yard, and waiting for next ship, which manifests current supply chain is far away from perfection. Such kind of financial issue has impact on the performance of the transport project, but it has gone beyond the range of transportation solution. Its solving relies on more communications, understanding and trust between the management levels of each side, which will reduce risks in rig transportation and benefit the development of whole supply chain. (Jespersen & Larsen, 2005, p.27-28, 151)

7 Conclusion

The rig transportation is critical to the oil producing industry. To ensure the stable supply of large volume of rigs in the long term is a difficult job as the transportation involves a large number of factors, such as transport service, technical issues, financial issues, and organization and cooperation issues.

The article discuss the transportation project making, analyzes the transports mode features and market situation in China, investigated the issues such as transport routes, cost, time, capability and constraints as well as safety and quality of the service, argued that the land-water transport is the most suitable transport option for the rig which is heavy and bulky.

The AHP method is also adopted to establish the evaluation system for the rig transportation project, it proves the evaluation system is practical and valid as the result is incompliance with the practice.

Organization is one of the keys for the implementation of the project. To keep fluent information collection and distribution, all parties involved need to keep close contact and clear responsibility. The close communications among them will help improve the performance of whole project. Mutual understanding and risks sharing are also of great significance to the project, which will finally benefit the supply chain.

REFERENCE LIST

Books

He J.Y. (2005) Operational Research, Edition 2000, (pp.5-16),Tsinghua University Press. Beijing, China.

Hitt, M.A., Ireland, R.D. and Hoskisson, R.E. (2005). Strategic Management, 6th Edition. (pp.52-57). South-Western, part of the Thomson Cooperation. Mason, Ohio, USA.

Jespersen, B.D. & Larsen, T.S. (2005). Supply Chain Management- in Theory and Practice. (pp.23, 26-28, 151), Copenhagen Business School Press, Denmark.

Yang, Z.G., Wu, Y.F. (1998). International Container Transport Practice.(pp.12-14), The People Transportation Press, Beijing, China.

Zhang,L.J.(2003). The Theory and Practice of Water Transport Pricing. (pp.149-150), The People Transportation Press, Beijing, China.

Zhou, Z.Q., Yang, Z.G. (2004). Modern logistics Management. The People's Transportation Press, Beijing, China.

Periodicals

Bulletin of the statistics of Chinese road and water transport industries development in 2004. (2005), Transport Accounting, (6/215), 62-65.

Chen, H. (2002, Oct). Enlightenment of from Europe inland navigation to development of China inland navigation. Port & Waterway Engineerin, (10/345), 39-41.

Chen, Q. (2004). The constraints of the development of modern railway logistics and the countermeasure. Railway Materials Scientific Management, (3),31-32

Dou H.J., Zhang X.D. and Zhang H.L. (2003). Study on the application of "level by level analysis method" in choosing traffic and transportation means. *Railway Transport and Economy, 25(4), 44-46.*

Expedite the development of the inland water transport and exploit the comparative advantages. (2004). Waterway Transport Digest, (8), 24-26.

Fang, F. (2001, March). Macroscopic analysis of inland water transport developing. Journal of Traffic and transportation Engineering, 1(1), 45-48

Han, B. (2003). Logistics and transport management. Logistics Technology,(5), 73-74.

Hao, Y.L., Ma, J. and Zhang, Z.Y.(2006, April). Game analysis of the partnership between transportation agent and industry. Journal of Transportation Systems Engineering and Information Technology, 6(2), 119-123.

Hu S.P. (2002). Strategy for transport mode choice. Logistics Management, 25(90), 6-10.

Huang, M.H., Zhang, S.B. (2005). Research of hydropower stations logistics project evaluation and selection. China Three Gorges Construction, (1), 39-41.

Huang, Q. (2003). The consideration of the modern logistics service development of the Yangtze River shipping industry. China Water Transport, (7), 2-3.

Huang, Q. (2004, November). Make the full use of the Yangtze River in shipping industry. China Waterway Transport, (11), 10-11.

Huang, X.M. (2000). The characteristics of transport industry and its organization. *Journal of Wuhan Communication Management Institute, 2(1), 29-31.*

Jia, D.S. (2004, June). The advantages of inland water transport in the development of domestic economy. China Water Transport, (6), 4-5.

Jiang, C.Z. (2003, October 20). Analysis of assurance of the smooth transport of large industrial equipment. East China Highway, (5/144), 81-83

Lang, M.X., Liu, Z.Y. and Huang, Y.C. (1999). The countermeasure for the development of railway heavy cargo transport. Railway Cargo Freight, (6),6-8

Li, D.X., Xiao, C.Q. (2005, May). Research of the Three Gorges Damp turbine's inland water Transportation project. Three Gorges Construction, (5), 65-67.

Li, S.M. (2005, August). The transportation of Dachaosan Hydropower station equipment. Mechanical&Electrical Technique of Hydropower Station, 28(4),20-21

Liu, J.J. (2003, April). The navigation safety in the Yangtze River. China Safety Science Journal, 13(4),29-31

Lu, W.J. (2000). The quality management system for large equipment transportation. Vehicle Transportation,(11), 7-8.

Niu, Y.L. (2006, March). Study on development of logistics service by road freight industry in China. Journal of Changan University (Social Science Edition), 8(1), 14-18.

Qing, X.H, Ye, H.Z. (2006). The main problems of Chinese road transport industry under modern logistics development and the countermeasure. Railway Transport and Economy, 28(4), 43-45.

Shang, M. Ying, J.J. etc. (2000, December 25). Study on route planning for heavy vehicles in Shanghai urban roads. China Municipal Administration, (4/91), 11-15.

Shun X.D. (2003), Analysis of the traffic accidents on the Yangtze River. China Water Transport, (10), 30

Suo, H.S. (2000, June). Study on development of logistics Service by Road Freight Industry in China. Journal of Highway and Transportation, 17(3), 82-86.

The prospect of the Yangtze River shipping market in 2003.(2003). Information and Literature of water transport, (3), 7-8.

Wang, W.D. (2006). The development of Chinese road transport logistics: current situation, trend, countermeasure. (7), 27-30.

Wu, M.Q. (2006,March). Reformation of Chinese domestic railway service, in comparison with German railway logistics. Technology Economy and Market, (3), 54-55

Wu, Y.Z.(2006). The development of Chinese road transport: fast, heavy and long-haul transport. Transport Business China, (Z1),42-44

Xiao, D.G. (2005,September). Improve the railway cargo freight equipment. Railway transport and Economy, 27(9), 8-10

Xu S.B. (2001). Study of problems in the large equipment road transportation. Fujian Power and Electrical Engineering, 21(04), 26-30.

Xu, G.Y. (2006, February). The third party logistics organization and operation for large equipment transportation. (2), 77-79.

Xu, P.H.(2000, February). The situation faced by the Yangtze River shipping Industry in the firat stage of the 21st Century. China Water Transport, (8), 19.

Yan, Z.P. (2000). Consideration on the exceed-limit road transportation. Vehicle transport, (10), 13.

Yang, A.X. (2006, March). Research of navigation accidents in the Yangtze River. Journal of Nantong Vocational & Technical Shipping College, 5(1), 71-73

Zai X.H. (2006). The tracking and tracing of the road transport. Transport Business China, 26 (4), 47.

Zeng, Y. (2005, January). The information coordination of logistics system of supply chain. Market Modernization,(2/455), 115.

Zhang, X.P. etc. (2006). Research of Chinese logistics total cost, 2005. China Materials Distribution, (4),24-29

Zhang, X.W. (2001, November). Inland waterway transportation and persistence development. Industrial Safety and Environmental Protection, 27(11),1-5

Zhao, Y.J. (2003, September). The land-water joint transportation of large equipment. Journal of Shijiazhuang Institute of Railway Engineering, 2(3), 44-49.

Zhen, Y.H. (2006). The unreasonable transport problem in the logistics. China storage & transport magazine (3), 115-116.

Conference Proceedings

Cheng, Z.D. (2001). The review and prospect of Chinese heavy and large cargo road transport. In *Academic Paper Proceedings of Shanghai highway Institute of the 4th Annual Conference* (pp.176-179). Shanghai: Shanghai Highway Institute.

Theses and Research Papers

Guo, J. (2003, July) *The large item transport program design of the pressure container for the nuclear reactor rile.* Unpublished master's thesis, Dalian Maritime University, Dalian, China

Huang, M.H.,(2004). *Research of hydropower stations logistics project evaluation and selection.* Unpublished master's thesis, Huazhong Science and Technology University, Wuhan, China

Ma, Y. (2005). *Study on freeway travel safety ensuring system under unfavorable weather condition*. Unpublished master's thesis, Changan University, Xian, China

Zhang, Z. (2005). *Study on permanent mechanism of regulating exceed-limit transportation on highway.* Unpublished master's thesis, Changan University, Xian, China

Lecture Handouts

Fu, Y.H. (2006). *Optimize the supply chain to integrate the export and import logistics.* Un published lecture handout, DHL, China.

Marlow, P. (2006). *Logistics challenges in globalized economy.* Unpublished lecture handout, Shanghai Maritime University, Shanghai, China

Muller, G. (2006). *Intermodal transportation.* Unpublished lecture handout, Shanghai Maritime University, Shanghai, China

Shi, X. (2006). *Strategies and organizational behaviors.* Unpublished lecture handout, Shanghai Maritime University, Shanghai, China

Xu, D.Z. (2006). *Marketing and service marketing.* Unpublished lecture handout, Shanghai Maritime University, Shanghai, China.

Electronic Sources

5 trends in the development of Chinese road transport. (2005). Retrieved March 2007 from the World Wide Web: http://202.121.212.103/kns50/scdbsearch/scdetail.aspx?QueryID=62&CurRec=1

Huangshi Bridge information. Retrieved March 2007 from the World Wide Web: http://www.hb.xinhuanet.com/newscenter/2006-04/07/content_6675791.htm

MCC web site for the development and situation of the road and water transport industries. Retrieved March 2007 from the world Wide Web:
http://www.moc.gov.cn
http://www.moc.gov.cn/06jiaotonggk

Shanghai traffic condition. Retrieved March 2007 from the world Wide Web:http://life.ptq.sh.gov.cn/WebFront/sub_XiangGuanlist.aspx?cid=72

The specifications of railway cars. Retrieved April, 2007 from the World Wide Web:
http://www.crif.com.cn/app/zhuce.htm

The Yangtze River Shipping Administration web site for traffic news and conditions. Retrieved March 2007 from the World Wide Web:
http://www.cjhy.gov.cn/
http://www.cjhy.gov.cn/Article/ShowArticle.asp?
http://www.cjhy.gov.cn/fwxx/ShowClass.asp?
http://www.cjhy.gov.cn/kjxh/ShowArticle.asp?
http://www.cjhy.gov.cn/tsfx/ShowArticle.asp?
http://www.moc.gov.cn/06changjianghw/shuiluxw
http://www.moc.gov.cn/06changjianghw/hangxingtg
http://www.moc.gov.cn/06hubei/jiaotongxw