Scientific Research

Case Study on Business Risk Management for Software Outsourcing Service Provider with ISM[*]

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Abstract

This paper identifies the risks of CN Group which is working at software outsourcing projects between HongKong and Guangdong, discovers the causal relationships among the risk factors, and constructs corresponding risk structure model with Interpretive Structural Modeling. Five original risk factors are identified, including contracts risk, requirements definition and change, lack of communication, political and legal environment differences, and exchange rate fluctuations. Finally, a risk management model of CN Group is put forward and three advices are proposed for software outsourcing business operation: project planning, project requirements, and communication.

1. Introduction

Software outsourcing is a major characteristic of economic globalization, a new form of innovation networks and strategic alliances, and also a strategic instrument for nurturing and promoting enterprises' core competitiveness. Outsourcing service providers who undertake software outsourcing face both opportunities and challenges [1]. With an increasingly competitive outsourcing market, it has been the industry's top priority to explore the risk management for China's software outsourcing business. The widespread failures of software outsourcing projects have attracted scholars to focus on the risks of the software outsourcing project [1]. Kliem & Ralph had discovered six risk factors leading to the failure [2].

However, these studies only implement isolated risk management in limited processes, without comprehensive consideration from the enterprises' operation level. In this context, issues studied in this thesis include: 1) What risks do software outsourcing enterprises confront? 2) How do software outsourcing enterprises respond to these risks? 3) Have there been appropriate risk management models for software outsourcing enterprises to

effectively carry out risk management? 4) How do software outsourcing enterprises guarantee the correct implementation of these risk management models?

There are many risks in the course of risk management of the software outsourcing enterprise, the risk factors contact each other and store each other, forming a multi-level, multi-link network structure. Therefore, the risk management of software outsourcing actually covers the whole process of the software life cycle; the risks can not be seen independently. Interpretive Structural Modeling (ISM) is the most practical technology of the structure modeling, and is most widely used in analyzing software outsourcing risks in the system with many variables, complex relationships and unclear structure. In this paper, we constructed a risk structure model for CN Group which is working software outsourcing projects between HongKong and Guangdong, and then found out some original risks to propose several solutions.

2. Software Risk Management

Literature 3 shows the comparison of 6 risk management models (**Table 1**). The core of Boehm's risk management theory is to maintain and update a list of the top ten risks [4]. Software risk management principles of CRM (Continuous Risk Management), include a comprehensive

view, positive strategies, open communication environment, integrated management, continuous process, a common goal and coordinative working. CRM model proposed by SEI demands to pay close attention to risk identification and management in all stages of project life cycle [5]. Riskit method can provide systematic risk management processes and technologies of early stage, aimed at completely indicating and managing the causes of risk, the trigger events and their impacts, and assessing risk with reasonable steps. Riskit method provides the detail implementation template to each activity of the risk management [6]. SoftRisk model is proposed by Keshlaf and Hashim. The core of this model is to continuously identify and control risk, and manage risk through updating and maintaining the list of top ten risks which are based on Boehm theory [7]. IEEE risk management standard defines risk management processes during software development life cycle [8]. It systematically describes and manages the risks emerging in product or service life cycle, including the following activities: planning and implementing risk management, managing project risk list, analyzing risk, monitoring risk, handling risk, and evaluating risk management process. Software Risk Management process area is the third level of CMMI [9], which is to identify potential factors that could jeopardize key objectives so that countermeasures can be planned and implemented when necessary to ease the negative impact and eventually realize the organizational goals.

The practice of software risk management involves two primary steps each with three subsidiary steps by Bohem is illustrated in **Figure 1** [4].

The first primary step, risk assessment, involves risk identification, risk analysis, and risk prioritization: 1) Risk identification produces lists of the project-specific risk items likely to compromise a project's success. Typical risk identification techniques include checklists, examination of decision drivers, comparison with experience (assumption analysis), and decomposition. 2) Risk analysis assesses the loss probability and loss magnitude for each identified risk item, and it assesses compound risks in risk item interactions. Typical techniques include performance models, cost models, network analysis, statistical decision analysis, and quality-factor (like reliability, availability, and security) analysis. 3) Risk prioritization produces a ranked ordering of the risk items identified and analyzed. Typical techniques include risk-exposure analysis, risk-reduction leverage analysis (particularly involving cost-benefit analysis), and Delphi or group-consensus techniques.

The second primary step, risk control, involves risk-management planning, risk resolution, and risk monitoring: 1) Risk-management planning helps prepare you to address each risk item (for example, via information buying, risk avoidance, risk transfer, or risk reduction), including the coordination of the individual risk-item plans with each other and with the overall project plan. Typical techniques include checklists of risk-resolution techniques, cost benefit analysis, and standard risk management plan outlines, forms, and elements. 2) Risk resolution produces a situation in which the risk items are eliminated or otherwise resolved (for example, risk avoidance via relaxation of requirements). Typical techniques include prototypes, simulations, benchmarks, mission analyses, key-personnel agreements, design-to-cost approaches, and incremental development. 3) Risk monitoring involves tracking the project's progress toward resolving its risk items and taking corrective action where appropriate. Typical techniques include milestone tracking and a top-10 risk-item list that is highlighted at each weekly, monthly, or milestone project review and followed up appropriately with reassessment of the risk item or corrective action.

Table 1. Comparison of risk management models.

Model	Characteristic	Model complexity	Core activities of model
Barn-Boehm Theory	Identify risks and maintain a list of the top ten risks	low	Risk identification
CRM model of SEI	Continuous risk management, emphasizing on communication of risk	low	communication
Riskit method	Continuous risk management, manager expectation's influence on risks, modeling risk with a graphical tool, Riskit analysis diagram, and with software support	high	Standard definition of risk management
SoftRisk risk management model	Continuous risk management, maintain a list of the top ten risks, risks statistic	middle	statistic
IEEE risk management standard	Continuous risk management, continuous improvement, executives developing standards, being able to manage project and organizational risks	middle	Risk management description table
CMMI risk management process area	Continuous and prospective risk management, continuous process improving	middle	Risk database

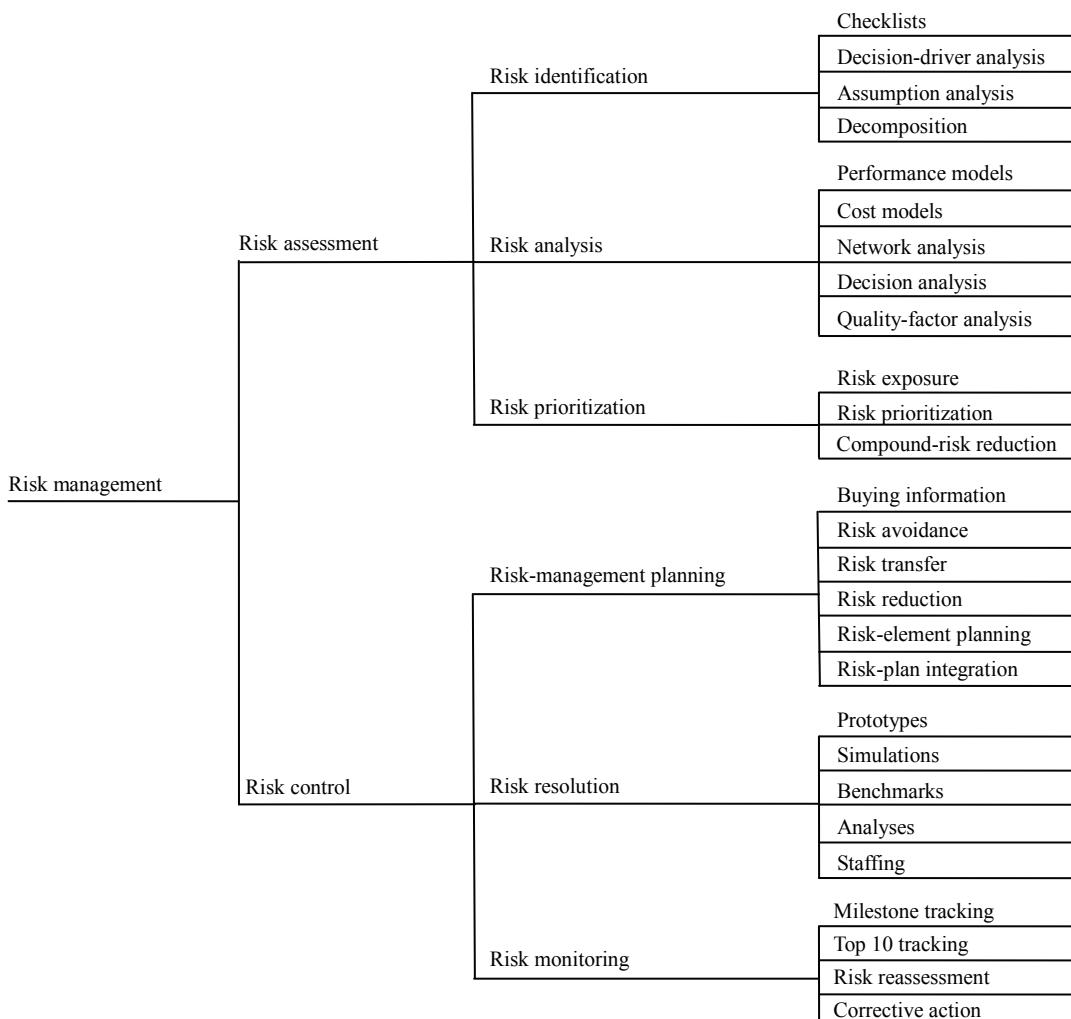|			
		Risk identification	Checklists
			Decision-driver analysis
			Assumption analysis
			Decomposition
	Risk assessment	Risk analysis	Performance models
			Cost models
			Network analysis
			Decision analysis
			Quality-factor analysis
		Risk prioritization	Risk exposure
			Risk prioritization
			Compound-risk reduction
Risk management		Risk-management planning	Buying information
			Risk avoidance
			Risk transfer
			Risk reduction
			Risk-element planning
			Risk-plan integration
	Risk control	Risk resolution	Prototypes
			Simulations
			Benchmarks
			Analyses
			Staffing
		Risk monitoring	Milestone tracking
			Top 10 tracking
			Risk reassessment
			Corrective action

Figure 1. Software risk management steps.

3. Analysis on Risks of CN Group

CN summarized its risks having the following characteristics.

1) The objectivity and universality of risk. As the uncertainty of loss, a considerable part of the risk of CN Group can not completely controlled. These objective risks exist not only in software outsourcing project life cycle, but also in the operations of CN group. Although the CN group wishes to fully understand and control risk, but until now it can only change the conditions of risk existence and occurrence, reduces risk frequency and mitigates risk damage in limited space and time, but cannot eliminate it.

2) The contingency of a particular risk and inevitability of a number of risks. In the software outsourcing projects of CN Group, the occurrence of any specific risk is caused by many risk factors and other factors together, thus it is a random phenomenon. However, some risks can be controlled and forecasted through observation and statistical analysis of substantial risk accident data.

3) The variability of risk. This refers to the various risks changing in terms of quality and quantity in the entire project process. As the project goes on, some risks will be controlled, some will occur and get handled, and at the same time new risks may rise in every stage of the project. Especially in large projects, due to more risk factors, the variability of risk is much more pronounced.

4) The diversity and multi-level of risk. CN Group is a software outsourcing company, and responsible for several large software outsourcing projects. These software outsourcing projects have long life cycle, large-scale, broad scope and numerous risk factors of various types, resulting in that various risks will be confronted in its entire life cycle. Furthermore the intrinsic relationships between risk factors are complex, and cross-impacts of various risk factors between and external factors endow the multilevel risks.

4. Construct Software Outsourcing Risks Structure Model of CN Group with ISM

4.1. Identify the Risks of the Software Outsourcing Project

The major event sequence of ISM is in the following [10]: 1) Theme is selected. 2) Developer is identified. 3) Elements and contextual relation are identified. 4) Leader is identified. 5) ISM program is entered in computer. 6) Adequate computer time is allocated. 7) Facilities are ready. 8) Session plan is complete. 9) Computer contains elements and contextual relation. 10) Session can begin. 11) Element set is edited. 12) Reachable matrix is complete. 13) Total structure is available. 14) Amendments are complete. 15) Final structure is satisfactory.

According to major event sequence of ISM, We organized eight experts to form an ISM panel. Because of the consideration for confidentiality, eight experts all come from CN Group. ISM panel set problems and identified risk factors regularly (every three months). After several discussions, the members of ISM panel reached a consensus. Finally, 21 major risk factors of software outsourcing projects were found out. These risks can be illustrated in **Table 2**.

4.2. Construct Concept Model and Reachable Matrix

The concept model is constructed according to risk factors. After analysis, we propose a reasonable schedule of the relationships among risk factors of CN Group. It is illustrated in **Table 3**.

Table 2. Major risks software outsourcing of CN group.

Number	Risk factor	Description
S_1	Research and development risk	The operation problems caused by research and development
S_2	Human resources risk	The personnel structure is not rational, the key personnel and project managers are lack of experiences
S_3	The risk of requirement definition & change	The products was unclear, the requirement changed continually, resulting in increasing costs
S_4	Cultural differences	Cultural and values differences among different countries cause problems in work team
S_5	Enterprise decision-making blunders	By the wrong analysis of finance, technology, strategy, and the occasion
S_6	Contractor risk	By the inaccurate assessment of the contractor's core competencies and process capability
S_7	Contract risk	The contract defects and the wrong choice of contract type caused by the weak capability of contract
S_8	The lack of client support	In the information, communication, resources, technology, and finance is critical to the successfulness of the project
S_9	Software outsourcing project risk	By technology, personnel capacity, resources, or lack of responsibility
S_{10}	After service risk	Service quality such as software maintenance, technical support, and training services
S_{11}	Losing control of milestones	Lack of supervision plan and inattention of third-party commissioner
S_{12}	Inaccurate evaluation criteria	The evaluation criteria document defects about contract, commissioner rules, and software test plans
S_{13}	Exchange rate fluctuations	The project profit will also be affected
S_{14}	Financial risk	Financial risk caused by the lack of follow-up funds
S_{15}	Political and legal environment differences	Cause problems in trade, legal awareness, and other issues
S_{16}	Lack of communication	The coordination mechanisms of client, contractor, and supervision do not work
S_{17}	Client risk	On the software products, the capability of software outsourcing enterprises, and supervision
S_{18}	Market risk	Services change, the risk of sales, the operational environment risks, competitors risk, and so on
S_{19}	Merger / acquisition risk	As a company in Hong Kong, CN Group is possible to be merged by other enterprise
S_{20}	CMMI implementation risk	CMMI is too rigid to run smoothly in the entire company, so it can not help to improve the efficiency of operation
S_{21}	Marketing risk	Because of the unpredictable impact by uncertain factors, it is possible to loss or add income

Table 3. Relationship among major risks software outsourcing business of CN group.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Factor
A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	S_0: CN Group risk
V	A		A		A		A		V	A		A						A	S_1: research / development risk
		A					V							V					S_2: human resources risk
	V		V			V													S_3: the definition and change of requirement
	V			A			V			A									S_4: cultural differentes risk
V	V		A		A	A		V											S_5: enterprise decision-making blunders risk
							V			A									S_6: contractor's risk
			V			V		V											S_7: contract risk
		A					V	V											S_8: the lack of client support
							A	A											S_9: software outsourcing project risk
V	A		A		A														S_{10}: software outsourcing project risk
	A																		S_{11}: losing control of milestones
			A																S_{12}: inaccurate evaluator
		V																	S_{13}: exchange rate fluctuations
																			S_{14}: financial risk
		V																	S_{15}: political and legal environment differences
			V																S_{16}: lack of communication
																			S_{17}: client risk
V		V																	S_{18}: market risk
																			S_{19}: merger / acquisition risk
																			S_{20}: CMMI implementation risk
																			S_{21}: marketing risk

There into: ①V denotes the row factor has effected on the column factor (the row factor result in the column factor); ②A denotes the column factor has effected on the row factor; ③blank denotes the row factor and the column factor are unrelated.

4.3. Establish a Re-Order Reachable Matrix After the Class Division

Class division means dividing different risk factors into different levels for the purpose of providing a risk factors structural framework with good hierarchy and causal relationships for risk analysis and risk management.

1) Reachable matrix shows all the direct or indirect impact relationships between different factors. 2) Reachable set R (Si). The reachable set of Si is a set of system elements those can be reached by Si in Reachable matrix or directed graph, denotes as R (Si). 3) Antecedence set A (Si). The antecedence set of Si is a set of system elements those can reach to Si in Reachable matrix or directed graph, denotes as A (Si).

Table 4 is illustrated the first level of Reachable set and antecedence set of risks in CN Group.

Using Boolean algebra operational rules on the adja-cency matrix, we can get a Reachable set. Because R(S0) = R(S0) ∩ A(S0), the highest factors set of the first layer L1 = {S0}. By redlining the corresponding rows and columns, we can get the Reachable set and antecedence set of the second layer. In the same way, the highest factors set of the second layer L2 = {S9, S19, S21}; the highest factors set of the third layer L3 = {S1, S4, S5, S10, S11, S18}; the highest factors set of the fourth layer L4 = {S2, S6, S8, S12, S13, S14, S15, S17, S20}; the factors set of the lowest layer L5 = {S3, S7, S16}. The re-order Reachable matrix is as follows (**Figure 2**).

4.4. Construct the Structural Model

According to the re-order reachable matrix, we can construct the risk structural model of CN Group. They can be illustrated by **Figure 3**. (There are 50 pairs of relationships here).

Table 4. The reachable set and antecedence of the first layer.

	$R(S_i)$	$A(S_i)$	$R(S_i)/A(S_i)$
S_0	0	0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21	0
S_1	0,1,9,21	1,2,6,8,12,14,17,20	1
S_2	0,1,2,4,10	2,16	2
S_3	0,3,12,17,20	3	3
S_4	0,4,9,19	2,4,6,15	4
S_5	0,5,9,19,21	5,13,14,15	5
S_6	0,1,4,6,10	6,7	6
S_7	0,6,7,12,14,17	7	7
S_8	0,1,8,10,11	8,16	8
S_9	0,9	1,4,5,9,10,11	9
S_{10}	0,9,10,21	2,6,8,10,14,17,20	10
S_{11}	0,9,11	8,11,20	11
S_{12}	0,1,12	3,7,12,16	12
S_{13}	0,5,13,18	13	13
S_{14}	0,1,5,10,14	7,14	14
S_{15}	0,4,5,15,18	15	15
S_{16}	0,2,8,12,16,17	16	16
S_{17}	0,1,5,10,17	3,7,16,17	17
S_{18}	0,18,19,21	13,15,18	18
S_{19}	0,19	4,5,18,19	19
S_{20}	0,1,10,11,20	3,20	20
S_{21}	0,21	1,5,10,18,21	21

$R' =$

L_1	S_0	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
	S_9	1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
L_2	S_{19}	1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
	S_{21}	1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
	S_1	1 1 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
	S_4	1 1 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
L_3	S_5	1 1 1 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
	S_{10}	1 1 0 1 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
	S_{11}	1 1 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0
	S_{18}	1 0 1 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0
	S_2	1 0 0 0 1 1 0 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0
	S_6	1 0 0 0 1 1 0 1 0 0 0 1 0 0 0 0 0 0 0 0 0 0
	S_8	1 0 0 0 1 0 0 1 1 0 0 0 1 0 0 0 0 0 0 0 0 0
L_4	S_{12}	1 0 0 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
	S_{13}	1 0 0 0 0 0 1 0 0 1 0 0 0 1 0 0 0 0 0 0 0 0
	$S14$	1 0 0 0 1 0 1 1 0 0 0 0 0 0 1 0 0 0 0 0 0 0
	$S15$	1 0 0 0 0 1 1 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0
	$S17$	1 0 0 0 1 0 1 1 0 0 0 0 0 0 0 0 1 0 0 0 0 0
L_5	$S20$	1 0 0 0 1 0 0 1 1 0 0 0 0 0 0 0 0 1 0 0 0 0
	$S3$	1 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1 1 1 0 0

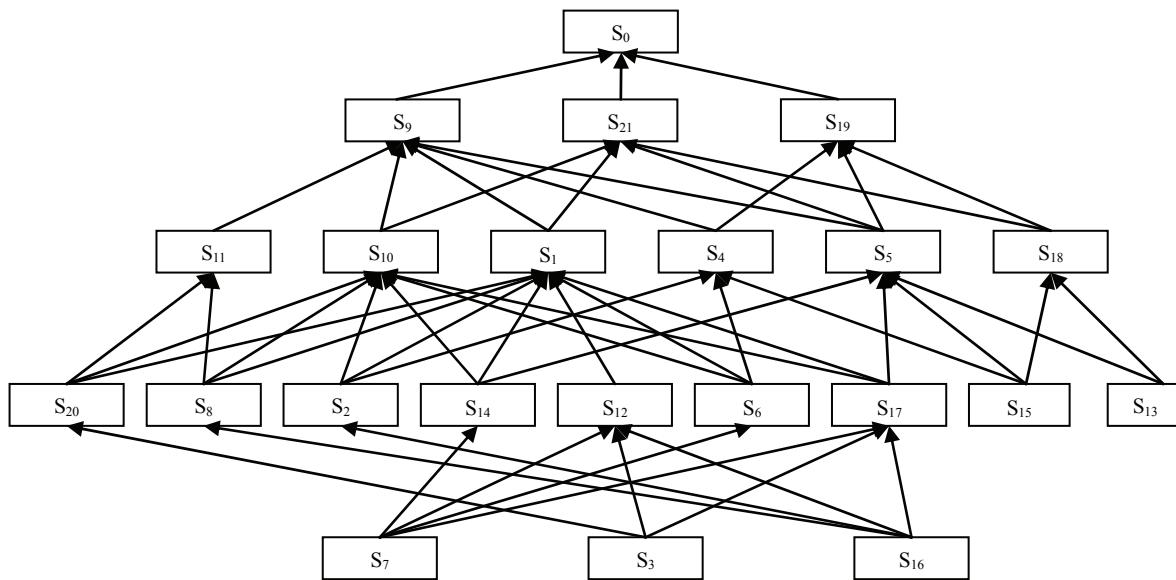**Figure 2. The re-order reachable matrix R'.**

Figure 3. ISM based business risk structural model for CN Group.

It can be seen from **Figure 4** that this model is a directed five-level hierarchical structure model, and that the bottom-line arrows indicate low-level factors affecting high-level factors. By replacing risk factors code with the actual risk factors, the interpretative structure model of CN's software outsourcing business risk is established.

5. Analyze the Interpretive Structural Model

After the analysis, we discover the software outsourcing business risks of CN Group constitute of factors in five level structures (**Figure 4**).

1) The lowest level constitute of contract risk, lack of communication, and the risk of requirement definition and change. They are the key factors affecting the successfulness of software outsourcing projects; although political and legal environment differences and exchange rate fluctuations are in the fourth layer, they are the bottom of the risks of CN Group; especially, the factors contract risk, lack of communication, and the risk of requirement definition and change occur in the early stages of operation of software outsourcing projects, having significant impact on the successfulness of CN Group's project.

2) The factors of the second layer is the direct risk factors resulting CN Group to crisis, including software outsourcing project risk, merger / acquisition risk, and marketing risk. Three risks separately belong to the project management, marketing management and enterprise management, but they are significant and correlative closely.

3) The software outsourcing project risk mainly due to losing control of milestones, research and development risk, after service risk, cultural differences, and enterprise decision-making blunders risk. The deeper reasons are CMMI implementation risk, the lack of client support, human resources risk, contract risk, financial risk, inaccurate evaluation criteria, contractor risk, and client risk. The original risks are contract risk, lack of communication, and the risk of requirement definition and change.

4) Marketing risk mainly due to enterprise decision-making blunders risk, market risk, research and development risk, and after service risk. The deeper reasons are financial risk, human resources risk, client risk, political and legal environment differences, and exchange rate fluctuations.

5) Merger / acquisition risk mainly due to cultural differences, enterprise decision-making blunders risk, and market risk.

6. Risk Management Model of CN Group

The existing risk management process in CN Group has included general processes for risk warning, analysis, plan, response and tracking in the outsourcing risk management model (**Figure 5**).

Risk early warning is the regular or irregular action of software outsourcing enterprises. CN Group needs to appoint a risk warning manager, being solely responsible for the work of risk warning. Risk warning manager reports directly to the CEO.

Risk identification is an attempt to determine risk factors that threat software outsourcing business with a systematic approach. CN Group should start with focusing on the issue that what scope, schedule, cost and quality problems could possibly emerge in the risks they face,
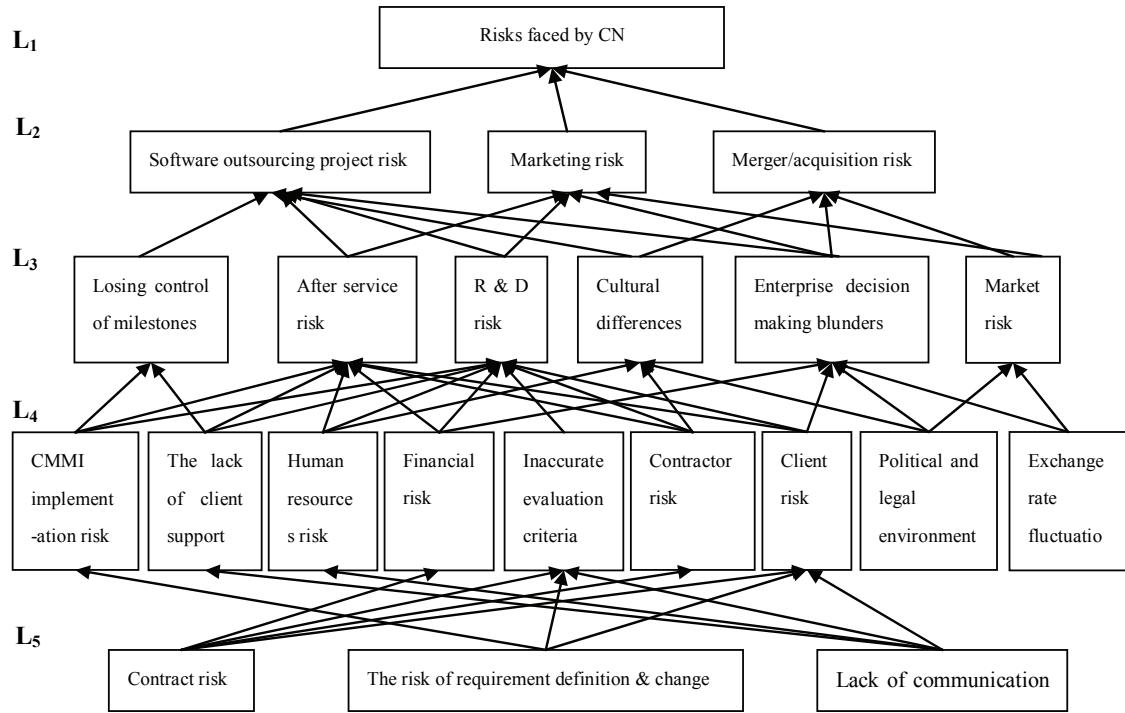
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L₁

Risks faced by CN

L₂

Software outsourcing project risk

Marketing risk

Merger/acquisition risk

L₃

Losing control of milestones

After service risk

R & D risk

Cultural differences

Enterprise decision making blunders

Market risk

L₄

CMMI implement -ation risk

The lack of client support

Human resources risk

Financial risk

Inaccurate evaluation criteria

Contractor risk

Client risk

Political and legal environment

Exchange rate fluctuatio

L₅

Contract risk

The risk of requirement definition & change

Lack of communication

Figure 4. Interpretive Structure Model of CN's Software Outsourcing Business Risk.

Uncertain knowledge
Other issues considered

CN Group's risk management strategy Risk management plan CN Group's resources

Risk measure specification and trigger

Risk tracking

Risk status

Risk indicator

Risk threshold

Risk warning → Risk identification

Risk statement

Risk context

Risk analysis

Risk lists

Risk plan

Risk action plan

Risk response

Risk executive

Risk management group

Risk checklist Risk assessment Risk management form

Risk assessment criteria Risk analysis tool ISM analysis tool

Risk goal quantization Risk response policy selection criteria

Risk tracking skills and tools

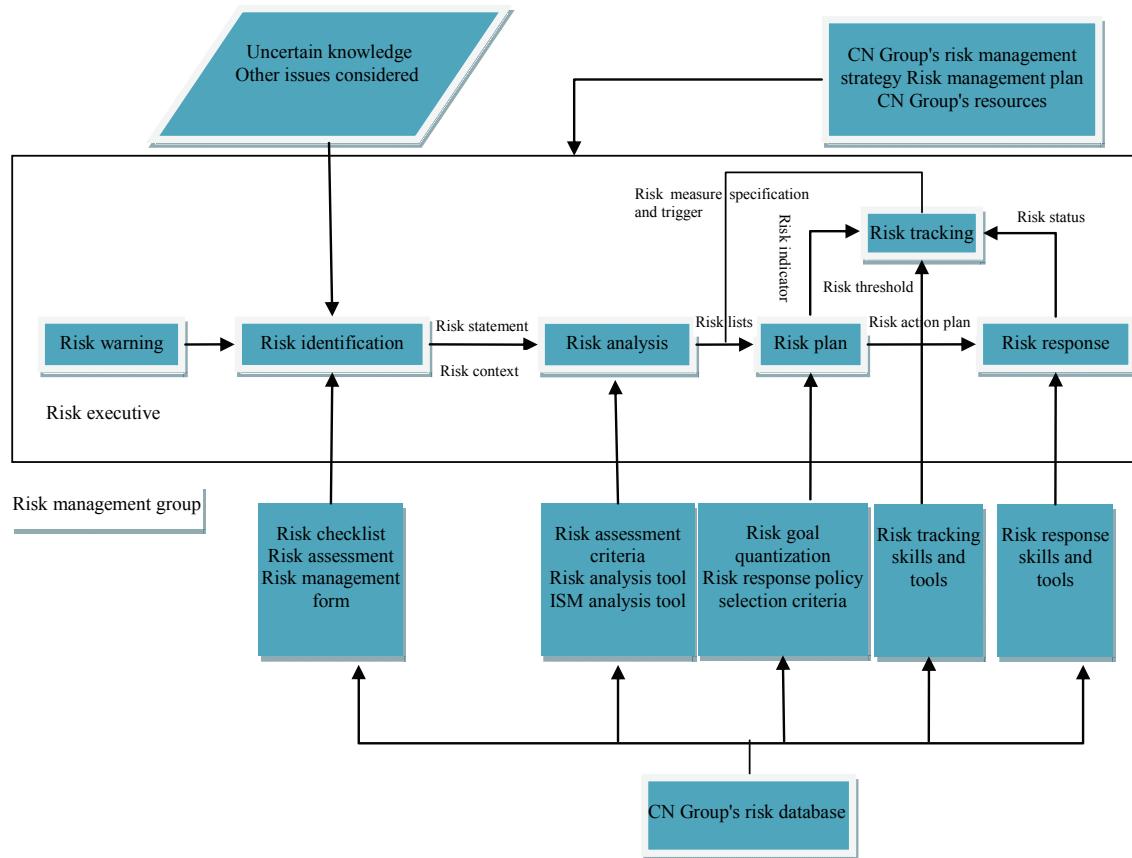Risk response skills and tools

CN Group's risk database

Figure 5. Risk Management of CN Group.

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mainly to discuss and list the possible risks.

Risk analysis is divided into qualitative risk analysis and quantitative risk analysis. Qualitative risk analysis is a process to assess the impact of the identified risks and their likelihood. For example, we can clearly find out the causal relationship of risks involved in software outsourcing process through structural analysis on the risk of CN group with ISM model. Thus we can determine the root of the important risks from the complex risk signs.

Risk action plan should contain the following elements: responsibility, resources, time, activities, response measures, results and person in charge.

CN Group can choose the following types of risk-response strategies: 1) controlling risk. 2) accepting risk. 3) transferring risk. 4) avoiding risk. It should adopt different response strategies according to different conditions, different environment or different issues of software outsourcing process.

The role of risk tracking is to monitor the status of the risk and check the validity of risk counter measures and whether tracking mechanisms are in operation, continue to identify new risks and develop strategies to provide the basis for active risk control.

7. The Countermeasures for the Risk Management of Software Outsourcing Enterprises

We advise the enterprises working at software outsourcing projects between Guangdong and Hong Kong should pay attention to the following aspects for managing risks:

1) Project requirement. A clear project requirement is the fundamental of the right project planning and implementation, so the contractor should gain some insight into the client's requirement before the project implementation, and discuss uncertain requirement with client. For the changes in the process of implementation, all participants should reach a consensus in the end. In requirement analysis, the contractor should carefully analyze the client's requirement, and then collect the client's complete requirement through business modeling, conversation, questionnaires, and requirement meeting.

2) Project planning. Prior to the implementation of the project, the client usually puts forward the draft of the implementation plan of the project, project managers should confer with client on the integrity and feasibility of the project plan, project process, workload, resource allocation and project milestones.

3) Communication. The implementation of the software outsourcing project is a cooperation process of both. It is necessary to establish an effective communication channel to ensure the outsourcing business to be carried out successfully. The contractor must confirm with client on which communication tools (telephone, fax, e-mail, online conversation, etc.) should be used under given circumstance, then determine format (for example, weekly format) and form of communication (for example, on spot, telephone, both project linkman).

8. Conclusions

This paper identifies the software outsourcing business risks of CN Group, and discovers the causal relationships among risk factors, and constructs corresponding risk structure model with ISM. Five original risk factors are found, including contracts risk, the risk of requirements definition and change, lack of communication, political and legal environment differences, and exchange rate fluctuations. Finally, risk management model is put forward for CN Group, and three advices are proposed: project requirement, project planning and communication to help software outsourcing providers between Guangdong and HongKong to find effective ways for software outsourcing project's success.

9. Acknowledgements

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