Risk Management during Technology Transfer – A case Study of Sanitation Project in Shangdong Province, China

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This thesis is submitted in partial fulfilment of the requirements for the degree of Master of Science in Built Environment from the University of London.

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Date: September 2008

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ACKNOWLEDGEMENT

The research on which this thesis is based was undertaken at the Bartlett School of Graduate Studies, University College London, under the supervision of Dr. S Ganesan. The author is greatly indebted to Dr. Ganesan for having provided this research opportunity and for his enthusiastic supervision, enlightening inspiration and continuing encouragement throughout the course of this investigation.

Special thanks are due to all the academic, technical and administrative staff at the Bartlett School of Graduate studies.

The author thanks to YingKou Dechang sanitation product Ltd, Shandong for providing the assistance that allow this research to continue, unhindered. This support is greatly acknowledged.

Last, the author is indebted to her grandmother, parents and brother for their understanding and encouragement, right from the very beginning. The completion of this research is very small reward for their support and great expectations.

ABSTRACT

In the mode choice and application of sanitation latrine with urine and faeces separation in China, it is very important to solved problem on hygienic safety during the course of faeces application and resource. In the recent 10 years, with the efforts of thousands of scientists, technologists on research and development work, eco-sanitation latrine and technique with urine and faeces separation had made great process in China.

Technology transfer plays an important role on the development of the sanitation projects in China. The TT in this report is defined as the transfer of advanced sanitation design, engineering and construction technology, skill, knowledge, and training material and so on to the transferee for the sanitation development.

This report identifies the risk and risk management involved in the sanitation project, and analysis the impact of the risks on the TT in sanitation project.

The Research objective is to investigate the risks and analysis the risk management solution in Technology Transfer during sanitation development projects in Shandong province, China.

Key words: Sanitation development. Risk. Risk management. Technology Transfer. China.

Word count: 9782.

The list of Appendices:

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Chapter 1 Introduction

1.1 Technology Transfer in China

China's rapid economic development is attracting the world's attention. In the context of economic globalisation featuring internationalisation of R&D and technology transfer, China's burgeoning economy is now ushering in another excellent opportunity (http://www.co-way.com.cn/download/China%20Technology%20Transfer(1st%20Issue).pdf).

Technology transfer (TT) generally speaking is the people or organisation with a solid understanding of the advantage knowledge, technology transfer it to the people with a relatively understanding the knowledge and technology (Please refer to chapter 2 for more detailed explanation).

TT has played an important role for China's repaid economic growth since 1978. International Technology Transfer from a developed country with advantage technology to China, or the Technology transferred between different province/cities in China are all qualified to the definition of TT.

The purpose of the Technology transfer is to strengthen the nation's economy by accelerating the application of technology and resources to private and public needs and opportunities. Product improvement, service efficiencies, improved manufacturing processes, joint development to address government and private sector needs, and the development of major new products for the international marketplace are the results of successful technology transfer efforts (Mings, 1998, p4-5).

1.2 Sanitation projects in China

Sanitation as the effective use of measures that create and maintain health environmental conditions. Among these measures are the safeguarding of food and water, proper sewage and excreta disposal, and the control of disease-carrying insects

and animals (Salvato, *et al*., 2003). Increasing rural access to safe, conveniently located water and sanitary latrines is a high priority for the Chinese government. Such investments are essential for continued poverty reduction in rural China because they dramatically improve health and living standards and promote social and economic development. The government has set ambitious targets in this regard, aiming for 95 percent of the rural population to have access to improved water supplies, 70 percent to have piped water supplies, and 65 percent to have sanitary latrines by 2010. (Meng, Yao and Liu, 2004, p1). In this report, the terms of sanitation project will focus on the project of rural sanitary latrine development if not otherwise stated.

1.3 Why choose Shandong province?

Picture 1: The map of P.R. China (source: http://en.wikipedia.org/wiki/Shandong).

Shandong Province is a coastal province in East China, which is in red colour on the above picture. Shandong province Located in the lower reaches of the Yellow River.

Zoning No.	Zoning Name	Provinces and municipalities covered	**Natural conditions**	**Social and economy development**	**Sanitation system**
Zoning 1	compact districts in the east and coastal towns	**Beijing** Tianjin Shanghai Jiangsu Zhejiang **Shandong** Guangdong	apparent seasons and abundant precipitation rain fall	swift economy development and adequate environmental investment	relatively higher level of sanitation and drinking water,

		Fujian and Hainan			better sanitation in rural area

Chart 1. Illumination for the zoning of China's eco-san development (Source: http://www.ecosanres.org/icss/proceedings/presentations/04--WANG-Rusong--EN.pdf)

Shandong province shares the same natural, social and economy development condition with Beijing – the capital city of China. Beijing has the most updated sanitation technology in China, and has the top research centres. It is convenient for the sanitation technology transfer to Shandong province from Beijing. Shandong province is one of the richest provinces in China, which enable the sanitation projects to have sufficient financial support and investment

1.4 Problem statement

1. Apart of a straight forward technology transfer, there maybe a requirement of innovation for the technology to suit local condition.
2. The manufacturers' reaction and response to the technology transfer. Are they willing to accept it, or think it is a threat to their current patent design.
3. Sanitation development project delivers the household level, which is means the end user is the individual family – there is a very simple question, are they willing to pay the maintaining fees?

1.4 Research Objective and Possible Outcome

The Research objective is to investigate the risks and analysis the risk management solution in Technology Transfer during sanitation development projects in Shandong province, China.

This report starts with Literature Review, which provides the theoretical guide to the research in Shandong province. The possible outcome of this report is to identify the

risks that mentioned on the problem statement section, and if possible discover the potential risks which haven't been noticed, or haven't been fully discussed in the Literature Review.

1.5 Research Methodology

There are two methods of the research in this report, namely primary research and secondary research.

Primary research: The author chosen an experimental project site for field research in Shandong province. This sanitation project is to install the Composting/urine diversion (UD) toilet to 1200 household families. The methods of the investigation and research contained investigation, questionnaires, interview, written record and personal observation.

Secondary research consists of literature review, reference materials, printed facts and report researching. The reference materials include text books, key notes, internet publishing material, magazines, business report and newspapers.

Chapter 2 Literature Review

2.1 Technology Transfer

Mings (1998, p4) defines Technology transfer in a large scale as the **process** by which **existing** knowledge, facilities or capabilities developed under federal R&D funding are utilized to **fulfil** public and private **needs**.

Souder, Nashar, and Padmanabhan (1990, p5) stated that Technology transfer is the managed **process** of conveying a technology from **one party to its adoption by another party**. Ganesan and Kelsey (2007, P1) expand the dimension of the "party" into "within a country, or from one country to another". "Conveying" implies a systematic interpersonal process of passing the control of a technology from one party to another. "Adoption" implies strong **emotional and financial commitments** to routine use. Thus, transfer efforts that do not achieve adoption are failures Souder, (Nashar, and Padmanabhan 1990, p5).

Technology transfer has been defined as the transfer of technical knowledge, the process of communicating research results to potential users, and the movement of technical ideas and know-how from a conceiving organization to a user organization at any stage of development. Effectiveness in the transfer process is often measured by the discrepancy between information transmitted and information received (Camp and Sexton, 1992, p68).

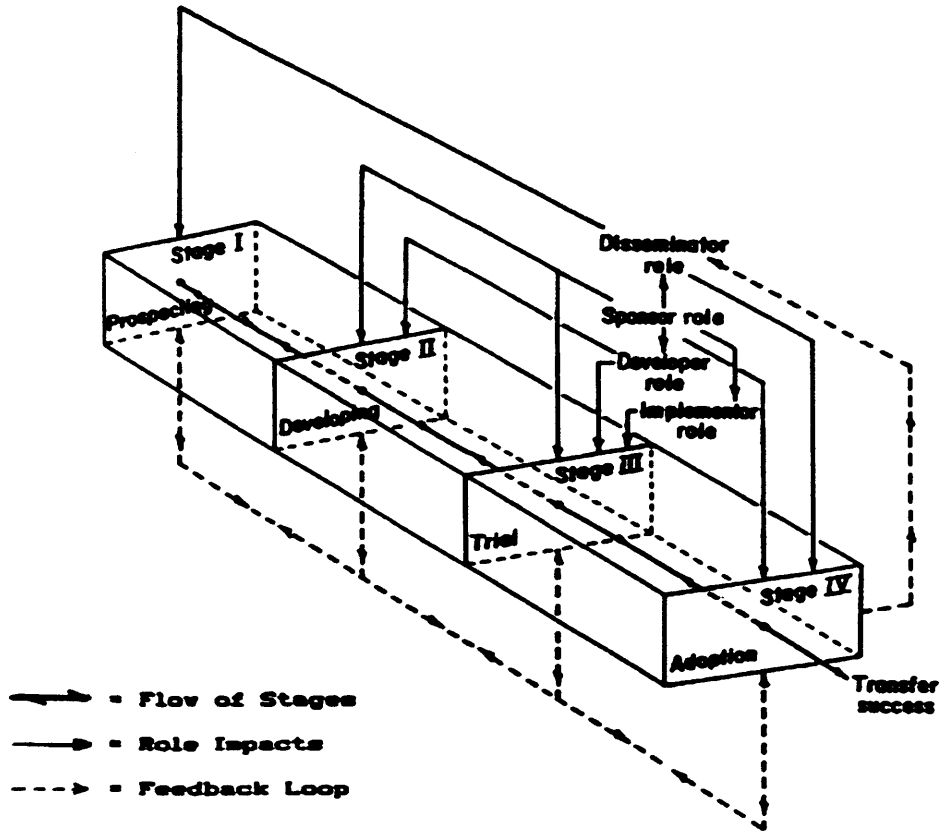


Chart 2. Technology Transfer Process (A guide to the best technology transfer practices, Souder, Nashar and Padmanabhan, 1990, p6)

As evidents in these definitions, technology transfer can be understood about the process of transfer technology, skill, knowledge, management method, technical know-how or equipment from the technology supplier (transferor) to the host party (transferee). An efficient technology transfer ensures further development of new or improved products, processes, applications, materials or services to the transferee.

Ganesan and Kelsey (2006, p8) quoted that the real tests of successful diffusion of advanced technologies though are whether new knowledge and skills have been permanently transferred to institutions and individuals within the recipient industry; whether such knowledge and skills are being applied to new projects; any technological

gaps have been reduced especially design, construction and management deficiencies in the local firms; domestic capacity to reproduce embodied knowledge in materials, components and equipment has increased and finally, sources of funding projects including minimal supplies of foreign exchange are adequately established and moderately sustainable.

There are several means by which technology is transferred from one state to another, including normal trade in goods (importing technology); licensing of technology; sharing of designs, patents, formulae, management style and accounting procedures in high-tech joint ventures; training of foreign employees; collaboration in basic and/or innovative research and development; and donated technologies, machinery, or equipment (US Commercial technology transfer to the people's republic of China, p2).

Different routes of technology transfer:

1. Conceptual and detailed design of projects;
2. Domestic production and imports of sanitation development resources such as materials, equipments and tools;
3. Training of skilled workers;
4. Execution of projects using new technologies from another city collaboration in the form of joint ventures, subcontracting arrangements;
5. Investment in the project that generates opportunities for replication or adaptation of newer technologies and growth in the local capacity to exploit them;
6. The local partner's capacities in fine-developed project collaboration. There are uncertain factors with regard to resources or programme for implementing about

technology transfer measure, examples are: non availability or shortage of skilled designers; likelihood of production of lower quality products or shortage of high quality materials and components and so on.

7.Risks arising from uncertain supply of resources or lack of certainty in solving problem faced during technology transfer.

(Ganesan and Kelsey, 2006, p745, amended by Lin Liu)

Hartley and Cronin (P6) write the critical Success Factors for Technology Transfer:

- It must work in a consistent and repeatable fashion.
- Delivered facilities must meet safety and operability requirements.
- The technical performance must meet expectations over the total operational life cycle.
- Knowledge and expertise are resident in the receiving organisation to a level than enables them to operate and maintain the process.
- Project cost and schedule objectives are met.
- Contractual obligations have been met.
- Long-term relationships are in place between the technology supplier and buyer.

2.2. TT in sanitation projects in China

China's campaign to improve water supply and sanitation began on a large scale in 1980. Activities overlap among institutions at the national, provincial, county, and village levels. Policy directives, design specifications, and engineering standards issued by the central government guide these efforts (Meng, Tao and Liu, 2004, p1). Design and engineering work are the first two standards assigned by the Chinese government and play the same important role as policy directives. There are various reasons for the

government guide to concentrate on these two areas, one possible explanation can be that the risks occurred in these two areas drawn the government's attention.

This report adds construction to the list together with design and engineering work as "with detailed design in hand, the contractor is ready to move into the next stage, which is to produce or **build** the end-item" (Nicholas and Steyn, 2008). The reason to select sanitation construction instead of sanitation product is that the sanitation product is more flexible for adaptation by other geographical areas than the sanitary building. China has thousands of cities and villages, if a sanitation product didn't have design or production faulty, but just do not suit for the certain geographical area, it may be able to adapt by another area with suitable land or water condition. However with the "one- off" nature, the construction site is nearly impossible for adaptation.

TT in sanitation project is the transfer of advanced sanitation design, engineering and construction technology, skill, knowledge, and training material and so on to the transferee for the sanitation development.

The activities in sanitation project include:

Design of sanitation equipment and component, sanitation plant and other relevant items, Construction of new sanitary latrines, and alteration of an existing sanitation latrine for product update and so on. The engineering work can be summarised as: sewage disinfection, use and compound of chemical products. Equipment (such as pumps and pipelines) and treatment plant installation, operates, maintains and management, maintain and repair pipelines and other mechanical drivers (including emergency repair), and quality testing, generating written reports on testing analysis and data recording.

2.3 Risk and uncertainties arising during Technology Transfer

2.3.1 Risk and uncertainties

Portny *et a.l* (2008) stated risk is the possibility that a project might not achieve its product, schedule, or resource targets because something unexpected occurs or something planned does not. By contrast, uncertainty is a lack of sureness that something will come to pass. Because it's impossible to predict the further with certainty, all projects have some degree of risk and uncertainty. However, project risk is greater in the following conditions:

1. The longer the project lasts.
2. The longer the time span between when a project plan is prepared and when the project begins.
3. The less experience the project manager, team members, or the organisation has had with similar projects in the past.
4. The newer the technology or work approaches that will be used.

Pinto (2007) writes that project risk is based on a simple equation: Risk = (probability of event) x (consequences of event)

Projects have innumerable risks, but only the important ones need to be addressed. Importance depends on the likelihood, impact, and overall consequence of the risk. Likelihood is the probability a risk will occur as determined by knowledgeable, experienced people. Risk impact is the effect of the risk, its seriousness or potential influence on project schedule, cost, or performance outcomes. Risk consequence is a combination of both likelihood and impact, a way of expressing the two concepts as one. Risk consequence measures are used to divide which risks should receive attention and which can be ignored. As a precaution, every risk with severe impact should be carefully

considered, even when the likelihood of occurrence is very small (Nicholas and Steyn, 2008).

Risk is always mentioned together with uncertainty that in general plays a negative role in the process of technology transfer, however with the utilization of the proper management method it can turn to be the future changes of the parameters of the projects together with a positive consequence on the schedule, costs or quality standards over the whole technology transfer lifecycle.

2.3.2 General risks faced by Technology Transfer

Nicholas and Steyn (2008) write that high risks in projects typically stem from:

1. Using am unusual approach
2. Attempting to further technology
3. Training for new tasks or applying new skills.
4. Developing and testing for equipment, systems, or procedures.
5. Operating in an unpredictable or variable environment.

TT is undoubtedly in this high risk category. Although TT as project has all the risks that a project may face, such as time, costs and schedule. As the nature of TT, the following risks need to take into account as the general risk in TT (Portny *et a.l*, 2008):

1. Product risk: the technology might not product the desired results
2. Schedule risk: task using the new technology might take longer than anticipated
3. Resource risk: the existing facilities and equipment might not be adequate to support the use of the new technology.

Nicholas and Steyn (2008) write that complexity and bloat ware occur when the product design is controlled by engineering and programmers, people who are technically astute

but often ignore "interaction design" - Those aspects of design that include product functions and how they are presented to the user.

Sanitation facilities construction plays an important role in the sanitation development projects. As people are unable to start to use or benefit from the sanitation facilities until the whole construction process finished. The complexity of client's demands, together with the increasing complexity of building, civil and industrial engineering, and other constructional work, particularly as a result of technological developments, has over the years resulted in increasing specialisation within the construction industry (Walker, 2007).

Engineering work involves with chemical products, such as the disinfection method, there are still more research need to be done for the reactions of disinfectants and their byproducts to be adequately understood and that the chemical side effects of disinfectants "should be examined in details" (Salvato, *et al.*, 2003).

A general introduction of the risks faced in TT has been introduced. The risks arising during the TT in sanitation project will be discussed in chapter 3 as the result of the field research.

2.4 The process of Risk Management - A risk reduction approach

Risk management is the process of identifying possible risks, assessing their potential impact on a project, and developing and implementing plans for minimising their negative effects. Risk management doesn't eliminate risks, but it gives project teams their best chance of successfully accomplishing the best chance of successfully accomplish their projects, despite the uncertainties of a changing environment (Portny *et al.*, 2008).

Risk management provided support for attempts to gain better control over a project when it comes to time (planning/schedules), money (estimates), quality, information and organisation. It does this by giving thought beforehand to the undesirable future events or

outcomes that might occur in a project, so that decisions may be made to take action early on it order to prevent or reduce the impact or of these events (Well-stam *et al.*, 2004). Dallas (2006) stated that a formal risk management process delivers the following benefits for the project team:

1. It requires that the management infrastructure is in place to deliver successful outcomes. This includes setting clear, realistic and achievable project objectives from the outset.
2. It establishes the risk profile of the project, enabling appropriate allocation of risk, so that the party best placed to mange it has the responsibility to doing so. Risk allocation is a key component of contract documentation.
3. It allows the team to manage risk effectively, concentrate resources on the things that really matter, resulting in risk reduction as the project proceeds. It also enables them to capitalise on opportunities revealed through the use of the process.
4. It improves confidence that the project will be delivered to the owner's and user's expectations, within the constraints of time and cost and to the required quality.
5. Quantification of risk assists management in the task of raising the necessary funds and, later, controlling the project by judicious application and draw down of the risk allowances. Where the project forms part of a larger portfolio of projects, it enables the transfer of risk allowance from one project to another.
6. It provides a mechanism for reporting risk on a regular basis to the appropriate levels of management, escalating severe risks in an orderly manner to obtain direction from the highest level.

Risk management is the process of the consistent development of a strategy to cope with risks that may occur at any time. The objective of the risk management is to contribute to the smooth project management, minimize the risk and losses, and react to perceived risks that comprise of threats and opportunities.

Chart 3 below provides an outline of the main steps in the risk management process. In essence, identifying, analysing, responding and monitoring risks are the key elements of the process.

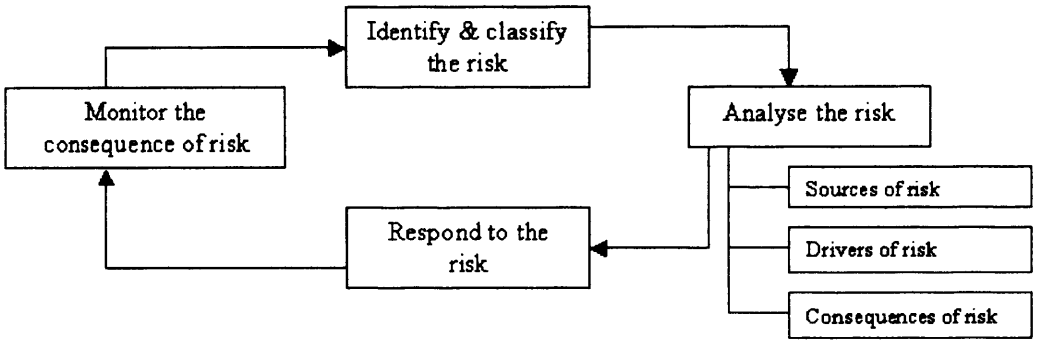


Chart 3. The risk management process. Source: Winch, Managing construction projects, (2002, p322), Amended by Lin Liu.

A more detailed explanation for each aspect of the risk management process is shown in Chart 4 below.

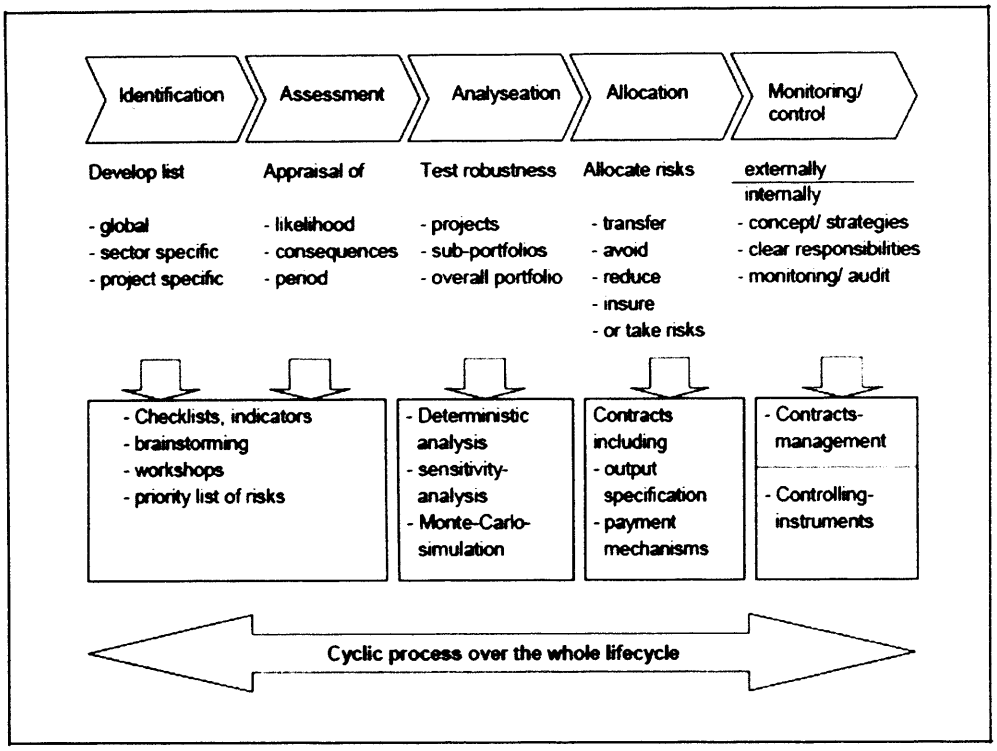


Chart 4. The risk management process. (Source: QUT Research Week 2005, Conference Proceedings, Elbing, C and Alfen, H.W., 2005, Australia. P5)

2.4.1 Identify and classify the risk

Lester (2007) writes that the risk identification is essentially a team effort to get the investigation going, the team may have a brainstorming session and use a prompt list (based on specific aspects such as legal or technical problems) or a checklist compiled from risk issues from similar previous projects. It may also be possible to obtain expert opinion or carry out interviews with outside parties. The end products long list of activities which may be affected by one or a number of adverse situations or unexpected occurrences. The risks which generally have to be considered may be:

Technical: new technology or materials. Test failures;

Environmental: unforeseen weather conditions, traffic restrictions;

Operational: new systems and procedures, training needs;

Cultural: established customs and beliefs, religious holidays;

Financial: freeze on capital, bankruptcy of stakeholder. Currency fluctuation;

Legal: local laws. Lack of clarity of contract;

Commercial: change in market conditions or customers;

Resource: shortage of staff, operatives or materials;

Economic: slow-down in economy, changes in commodity prices;

Political: change of government or government policy;

Security: safety, theft. Vandalism.

Pinto (2007) added more on the list above: Absenteeism, Resignation, Staff pulled away by management, Additional staff/skills not available, Training not effective as desired, Initial specifications poorly or incompletely specified, Work or change orders multiply due to various problems and Enhancements take longer than expected.

Identification techniques: Project risks are primarily identified from analysis of the numerous documents prepared during project conception and definition; these include reports from past projects, lists of user needs and requirements, work package definitions, cost estimates, schedules, and schematics and models or end- items (Nicholas and Steyn, 2008).

Rosenau and Githen (2005) state that the classification process helps the project management team to clarify what it knows and what it doesn't know, so team members can deepen their analysis and determine an action plan. The following labels work well for classifying the sources of project risk:

1. Technical risk source. These are sources associated with the design or operation of the project's product and / or production processes.
2. Logistic risk source. These are sources associated with regulatory or economic changes, supply, procurement, inventory, maintenance and support
3. Programmatic risk resources. These are sources associated with obtaining and applying program and project resources such as technical experts, project specific tools, and budgets for capital and project expenses.
4. Commercial risk source. These are sources of risk that changes assumptions and affect revenues, costs, market share, profitability, and so on.

As the first step of the risk management, this process identifies and classifies the risks from all aspects (internal and external) and start the risk management. It presents possible causes and effects of the risk. The risk assessment and early stage of possible solutions may also be mentioned in this stage to prepare for the further discuss. This step can be summarised risk recognition, and the preparation for the analysis, management and control of the risk.

2.4.2 Risk analysis

Once identified and listed, risks can be ranked according to the probability of their occurrence and the severity of the impact if they should occur. This process will eliminate the most improbable risks arsing from brainstorming, but it should bring to the fore those risks events that are most likely to happen or which would have the greatest impact on the project. For this analysis it is necessary to consider the possible causes and effects of every risk. Risk analysis can be qualitative or quantitative (Lock, 2007). It is

essential to analysis by analysis the sources (internal and external), drivers and consequences of risk.

Qualitative risk analysis involves assessing the likelihood and impact of identified risks, to determine their magnitude and priority (Schwalbe, 2007). A risk matrix chart has been introduced to determine the risk category (Buttrick, 2005):

Risk Matrix	Likelihood of event occurring			
Severity of Impact	Very unlikely <5%	Unlikely	Likely >50%	Very likely >75%
1. Minor impact on project schedule or cost	Low	Low	Medium	Medium
Major impact on project schedule or cost	Medium	Medium	Medium	High
Major impact on project schedule or cost. Major impact on benefit	Medium	Medium	High	High

Chart 5: Matrix chart (Source: Buttrick, R. The project workout, 2005, p396)

Quantitative risk analysis often follows qualitative risk analysis (Schwalbe, 2007). Quantitative analysis methods attempt to assign numerical value to risks and their possible effects. They often examine the probable impact on project time and costs.

Alternatively, for every identified risk, the evaluation process can produce a ranking number denoting the priority that a risk should claim for management attention and expenditure on preventive measures (Harrision and Lock, 2004).

Kerzner (2006) writes that risk analysis is often based on detailed information that may come from a variety of techniques, including but not limited to:

1. Analysis of plans and related documents
2. Comparisons with similar systems
3. Data from engineering or other models
4. Experience and interviewing
5. Modelling and simulation
6. Relevant lessons-learned studies
7. Results from tests and prototype development
8. Sensitivity analysis of alternatives and inputs
9. Specialist and expert judgments

2.4.3 Respond to the risk

Risk response is the development of effective risk mitigation strategies. In a general sense, there are four possible alternatives a project organisation can adopt in deciding how to address risks: (1) accept risk, (2) minimize risk, (3) share risk, or (4) transfer risk (Pinto, 2007).

Accept risk: not all impacts are sever or fatal, and if the cost of avoiding, reducing, or transferring risk is estimated to exceed the benefit, then "do nothing" might be the best alternative, sometimes nothing can be done to avoid, reduce, or transfer a risk, in which

case the risk must be accepted, regardless of the consequence. However the authors think such situations are rare (Nicholas and Steyn, 2008).

Minimize risk or reducing the impact of a risk event by reducing the probability of its occurrence (Schwalbe, 2007). The reducing strategy is used for any level of risk where the remaining risk is not of very high severity (very high probability and impact) and where the benefits (amount by which risk is reduced) outweigh the reduction costs (Vose, 2008).

Shark risk: if a project, or a substantial part of it, appears to carry very high risk, the contractor might seek one or more partners to undertake the work as a joint venture. The impact of any failure would be shared among the partners (Harrison and Lock, 2004).

Risk transfer involves manipulating the problem so that the risk is transferred from one party to another. A common method of transferring risk is through contracts, where some form of penalty is included into a contractor's performance. However the author also things this idea is appealing and used often but can be very inefficient (Vose, 2008). An example from the TT project can be that the performance guarantee of the product or design.

Nicholas and Steyn (2008) write that responding to a risk sometimes creates a new, secondary risk. Having planned a risk response, the project management team should check for possible secondary risk before implementing the plan.

2.4.4. Risk monitoring

The last step in the risk management process involves monitoring the trigger events associated with the risks, identifying new risks, and executing risk response plans or contingency plan when risk event occur (Milosevic, Martinelli and Wallddell, 2007).

Monitor the consequence of the risk is the final part of the process risk management cycle, as all the preparations, planning and acquired information from the pervious three parts have given this final part a clear frame of the impact of the risk. However as the risks may change over time and the consequence of the risk may occur new risks, the monitor the consequence of risk need to be carried out through the whole process of Technology transfer project. Data collection and document updating are also important in this stage.

2.5 Difficulties for the achievements of TT in sanitation project in Shandong province:

1. The regulations and system of environmental protection in rural areas is still weak
2. The fund and investment of the environmental protection in rural area is still weak
3. The infrastructure construction of environmental protection is insufficient
4. The supervising and managing ability of the environment protection in rural area is insufficient
5. The technical support of the environmental protection in rural area is weak
6. The propaganda, education and training of the environmental protection in rural areas is insufficiently.

(Wang and Zhang, p1, 2007, Amended by Lin Liu)

2.6. Summary of the Literature View

Nicholas and Steyn (2008) state that the implementation strategy to replace an existing system with a new one should address:

1. Approach for converting from the old system to the new system
2. Sequencing and scheduling for implementation activities

3. Acceptance criteria and test plan that will enable the customer to sign off on the system.
4. Approach to phasing out the old system and phasing in the new
5. User training
6. Installation details (for installation, check out, and acceptance of the end-item and side items)
7. Site preparation details (addressing security, access, power, space, equipment, etc)

TT in sanitation projects is a shared effort of multiple parties, from the technical and science experts, engineers, designers, and project managers to the technical transferees (normally the party that in the relatively lower level of the understanding of the technology, or the party that not own the advanced or new updating technology). The situation is further complicated by the fact that the various stages and tasks are highly interdependent which creates a vicious circle (Karhu, Keitila and Lahdenpera, 1997, p9). Technology transfer project is a complex one in any aspect and has risks, chances and unpredictable factors come from various sources. Like any other project, technology transfer has all the nature of the project, therefore it is under the risks that a project may bring. The potential risks can affect the schedule, costs, speed and quality of the technology transfer in sanitation projects. Being able to track the risk, identify the risk in an early stage of the project together with an effective risk management are the key elements for the project success.

Chapter 3 Empirical finding and analysis

The TT in sanitation project in Shandong province has never been a easy one, from the original "copy" and "paste", to has the ability to select the technology that suit regional condition (such as local environmental quality, land resource, bank line resource, and so on) is a long, hard and complex process.

The risk management process is also through a painful period, from "who cause the problem, who's going to have to solve it", to appoint the best project risk management team, from "everything runs smoothly, there is no risk", to set up the risk management process and risk management software to manage the risk and solve the problem

The successful implementation of TT is a contribution of many factors, risk management plays a important role in it.

3.1 Background of the selected sanitation project in Shandong province

In this report, the author select an experimental project site (sampling spot) in rural area in Shandong province for field research and investigations.

Chart 6. A brief introduction of the project:

Name and nature of the project	Install Composting/urine diversion (UD) toilet[1] to peasant farmer's family.
Aim of the project	Replace the unimproved pit toilet. Improve the rural environmental condition, and peasant farmer's living quality.
Size	Installation in 1200 household families
Total financial input	This project is set up by the Shandong province government, there is not cost for the peasant family. This project costs: The cost of the latrine: 160 Yuan/each The cost of construction work and material: 70 Yuan/each Other costs: 30000 Yuan Total costs: 30,6000 Yuan[2]

[1] Please refer to Appendix 2 for more details.

Product manufacturer	YingKou Dechang sanitation product Ltd, Shandong.
Construction contractor	Local contractor under the training by the technical engineers from YingKou Dechang sanitation product Ltd.

A brief introduction of YingKou Dechang sanitation product Ltd

The company is a fast growing and one of leading professional company dealing with design, manufacturing and distribution of environmental sanitation facilities and equipment in China.

The company has unique comprehension and understanding on modern rural furniture culture, and inheriting the enterprise concept of "development with science and technology". The company has integrated the most advanced technologies and the latest material resources to create its products.

The company started the TT project four years ago with Beijing academy for environmental and sanitation planning for the development of the composting/urine diversion latrine. The TT project is based on Beijing academy for environmental and sanitation planning transfers the advanced sanitation design, engineering and construction technology, skill, knowledge, training course and so on to YingKou Dechang sanitation product Ltd for the sanitation product development.

3.2 Risk management of the Technology Transfer in sanitation project

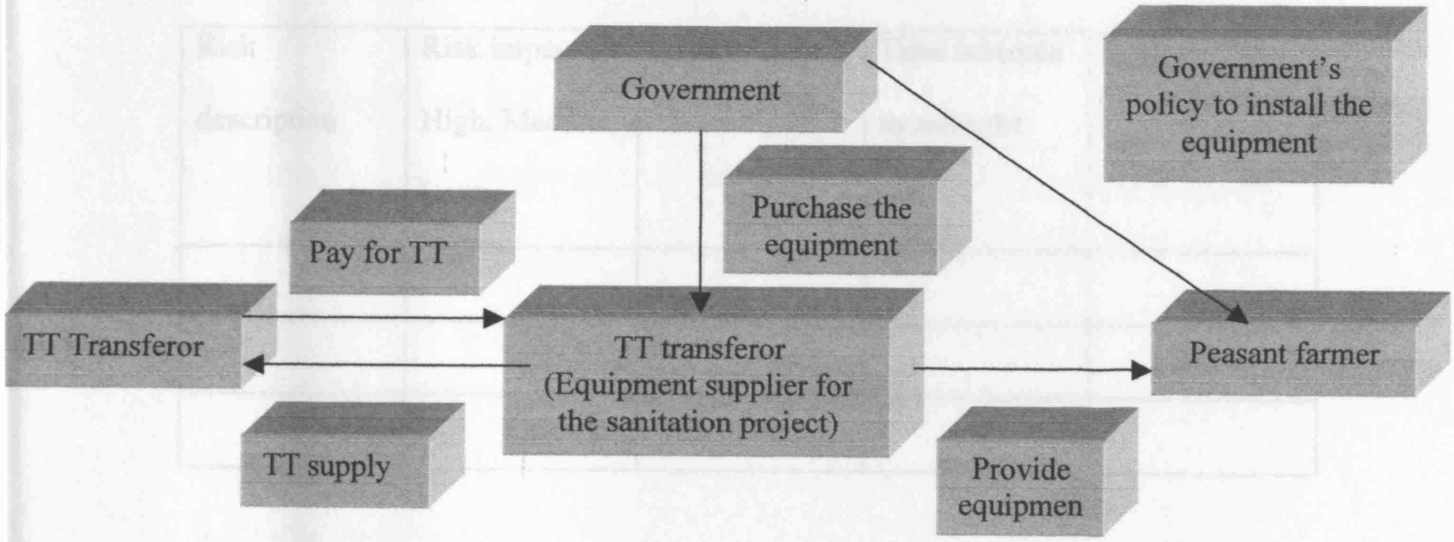
As a medium size company, YingKou Dechang sanitation product Ltd set up a very straight forward risk management process for TT in the sanitation project.

The risk managers in YingKou Dechang sanitation product Ltd and in Shandong province sanitation project will take the risk management responsibility in TT in the sanitation project, however they roles are different:

[2] The current exchange rate is about £1=13Yuan. The total cost is about £2,3540.

1. The risk managers in YingKou Dechang sanitation product Ltd as the TT transferee will take the all risk management responsibility because not having an efficient risk management will result to "no return from the investment and project failure".
2. As a project in a province level, the risk managers in the Shandong sanitation project have a lot of responsibilities. Their responsibilities in the TT is mainly focus on the training program that provided byYingKou Dechang sanitation product Ltd on the construction work. The risk management in TT in the sanitation project for them is in a "relatively minor" situation.

Chart 7. Demonstrate the relationship between the four parties:



From the result of the interview and questionnaire analysis, the risk managers in YingKou Dechang sanitation product Ltd and Shandong sanitation project share the same process of risk management, which is has been discussed in the previous chapter: Identify & classify the risk, analyse the risk, respond to the risk, and monitor the consequence of the risk. In this chapter, the risk management process is only focus on YingKou Dechang sanitation product Ltd.

3.2.1 Risk identification and classify

This is a team work leading by the project risk manager, whose responsibility is to identifying, assessing and tracking all the risks that may occur in the TT project. As the first step of the risk management. YingKou Dechang sanitation product Ltd invites people from different areas with knowledge and experience, and experts to discuss the risk involved in TT, especially risk in design, construction and engineering. The identification and classify process is mainly on group discussion and workshop, together with field research. The company designed a risk management planning sheet to documenting the risks for the next stage of the risk management process and for further reference as well:

Risk description	Risk impact High. Medium. Low	Type of risk	Time schedule to solve the risk	Responsible

Char 8. Risk planning chart (Translated by Lin Liu)

3.2.2 Risk analysis

This is the process to analysis the source, driver and impact and consequence of the risk, all these factors must be addressed to each risk. Consequence of the risk can be the delay of the project, project failure or increase the cost and on. The company design a risk management matrix for qualitative analysis:

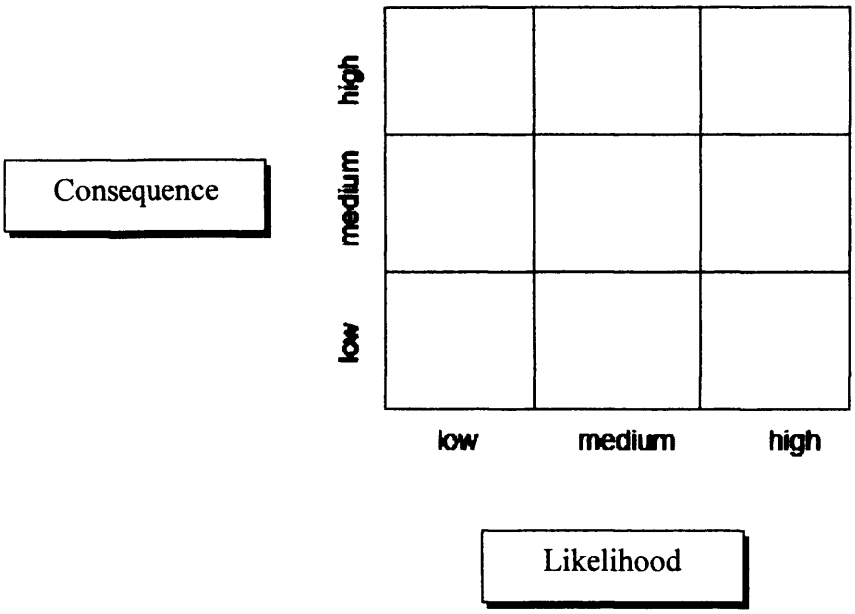


Chart 9. Likelihood-Consequence risk matrix. Translated by Lin Liu

3.2.3 Respond to the risk

This process applies the management methods and techniques to developing options and determining actions to deal with the known risks, to reduce the threats to the achievement and expectation project objectives and goals. The risk handling options as accept risk, minimize risk, share risk, or transfer risk have been discussed in the pervious chapter.

3.2.4 Risk monitoring

Risk monitoring is the last major element of risk management, and should be an ongoing and continuing process through the project and project risk management cycle. The main activities in YingKou Dechang sanitation product Ltd can be summarised as following:

1. Monitoring the residual risks
2. Monitoring the changes in the business environment and news risk comes all the times.

3. Monitoring the impact and consequences of the risks, as sometimes the new risks may come from the consequences of a solved risk.

Risk and risk management solution of TT in the sanitation project in Shandong province:

Sanitation project is a shared effort of multiple parties, from the designer, project manager, contractor to the field worker. TT as project is also a very complex one, both of the projects have risk, uncertainty and chances come from various sources. As the result from the field research, the risks occurred in sanitation project in Shandong province focus on the Design, construction, engineering, investment and management.

3.3 The risk analysis during the TT process will show in page 37-41.

3.4. Four special findings from the field research

These four findings may not directly link to the TT, however it can be the potential risks that the TT in sanitation projects may face.

3.4.1 Special Finding 1

This finding is based on the interview of 7 peasant farmers and the answer from 52 questionnaires.

In all, carrying on the sanitation latrine project which was greatly approved by they villagers, and they made a very positive function in improving the village sanitation environment and they strongly believe that it worth being expanded strongly. However, there were some problems in terms of peasant farmer's concerns of rebuilding latrine, publicity and training, policy and cooperation, complexity of the equipment and funds for the maintaining and repair fees.

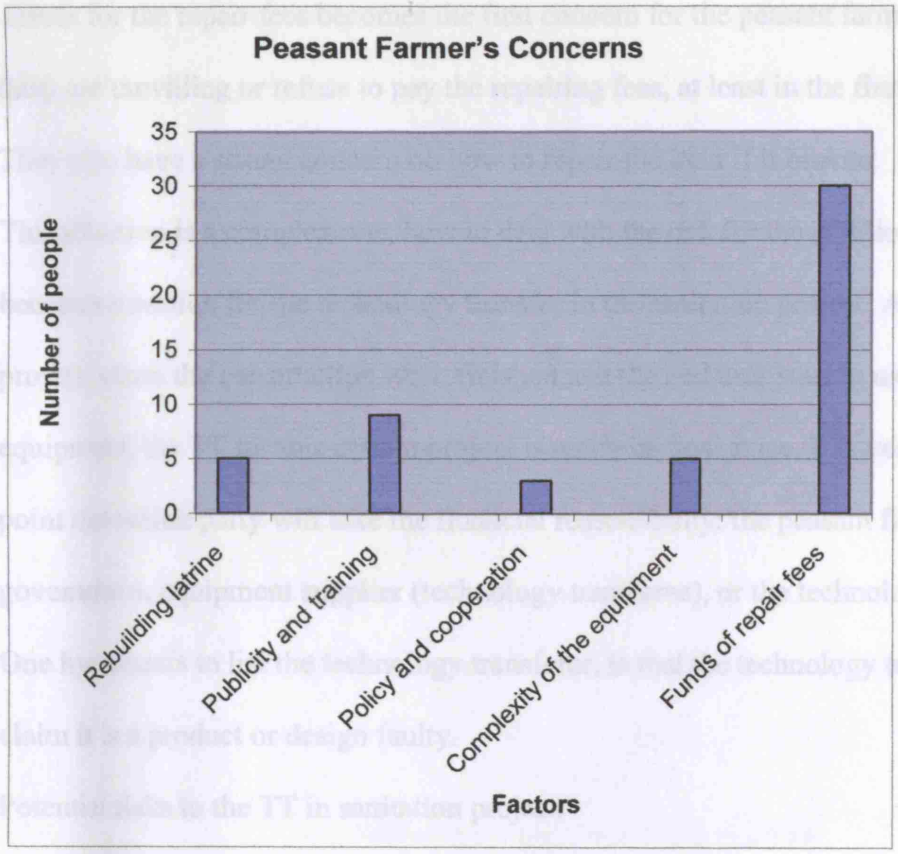


Chart 10: Peasant farmer's concerns

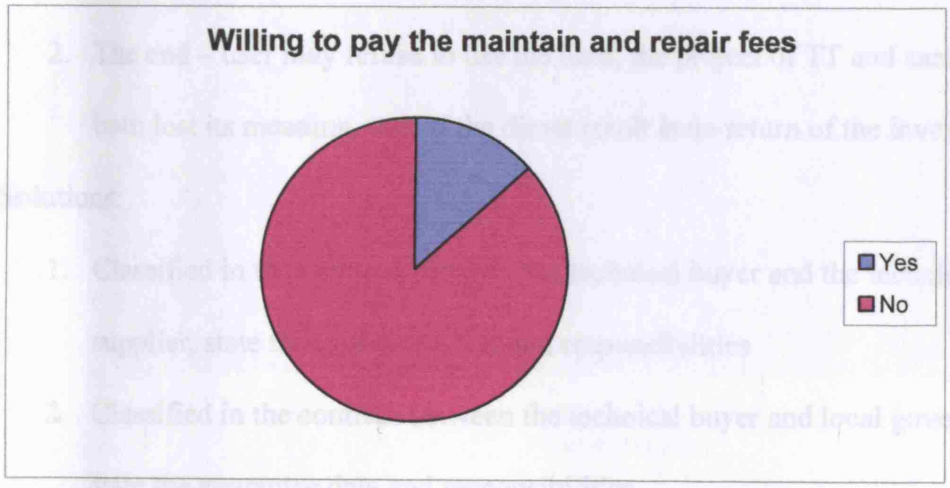


Chart 11: Willing to pay the repair fees

Funds for the repair fees becomes the first concern for the peasant farmers, most of them are unwilling or refuse to pay the repairing fees, at least in the first 2-3 years. They also have a strong concern on how to repair the item if it broken.

This situation is a complex one, how to deal with the risk for the additional fees becomes question for the technology transfer in the sanitation project. As a one-off project, when the construction work finished and the end user start to use the equipment, the TT for this certain project is reach its final stage. It is very hard to point out which party will take the financial reasonability: the peasant farmer, the government, equipment supplier (technology transferee), or the technology transferor. One hypothesis to list the technology transferor, is that the technology transferee may claim it is a product or design faulty.

Potential risks to the TT in sanitation project:

1. This situation maybe taken into account as "bad past experience", the further TT project may be affected.
2. The end – user may refuse to use the item, the project of TT and sanitation both lost its meaning, one of the direct result is no return of the investment.

Solutions:

1. Classified in the contract between the technical buyer and the technical supplier, state the guarantee date and responsibilities
2. Classified in the contract between the technical buyer and local government, state the guarantee date and responsibilities
3. List the most fragile part on the introduction book, and supply an extra one with the equipment.

4. Set up training course for the peasant farmers and video it for further reference.

3.4.2. Special finding 2

This finding is based on the interview of 7 peasant farmers and the answer of 52 questionnaires.

Rural sanitation project is one of the few projects in China that has100% government's financial support, on the other hand, the government pays for the cost for the peasant family to install the sanitary latrine.

However the rate of willingness for the peasant farmer to pay for the sanitation latrine is low, there are also some people never heard of sanitary latrine until they have it.

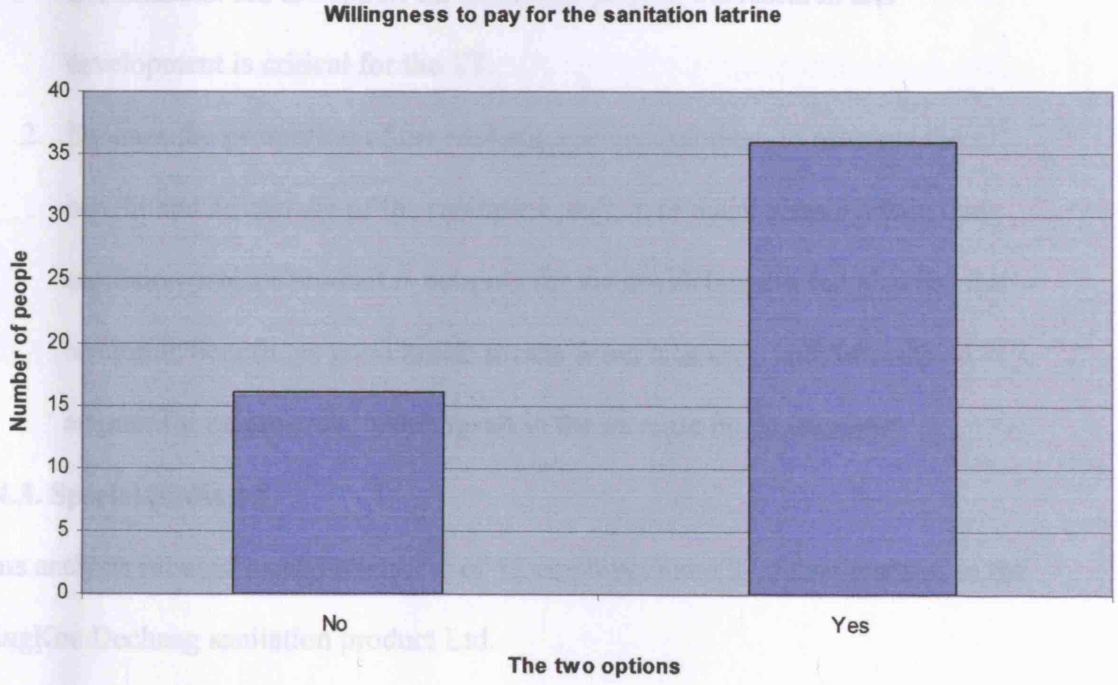


Chart 12: Peasant farmer's attitude toward to pay for the sanitation product fee.

Potential risks to the TT in sanitation project:

There are some questions need to be pointed out:

1. If the government change the development policy/regulations to the sanitation promotion, will the peasant farmer like to pay for the installation of the sanitary latrine?
2. If the peasant farmer refuses to pay for product, and the equipment supplier is unable to continue the business, will the TT process in sanitation project still exit?

If both of the answers are "no", then there is a risk, and the consequence will be the termination of the TT process.

Solutions:

1. A stable policy/regulations situation and a continuing rapid economic growth is the fundamental part for the TT transfer in sanitation project. The policy and financial aid to support the sanitation project, the research and development is critical for the TT.
2. Enhance the promotion of the sanitation project/product, to promote the benefit and advantage of the sanitation project, to make people aware that sanitation project/product is not only for the health benefit, but also has the economic benefit, as good health means fewer sick days and the reduced amount for health care, which result in the increase on productivity.

3.4.3. Special finding 3

This analysis is based on the interview of 12 employees and 37 questionnaires in the YingKou Dechang sanitation product Ltd.

As for the TT in the industry co-operation level, the CEO of YingKou Dechang sanitation product Ltd, Mr Zhang states his understanding of technology transfer:

1. Form a central force and a team
2. Share resources and build up combined force

3. Give training, guidance, provide technical information service, exchange experience and carried out inter country and international cooperation and communication
4. Seek win-win with companies by doing technical research and development and market development; and

His concern of the risk in TT project is:

The technology transfer in his company is never a straight forward one, there always has the requirement for alternation to suit the local needs, some of his staffs feel the threat to loose their patent design and he himself sometimes has the feelings of not independent anymore. One of his top managers complained to him—"the business is not bad, why change?"

Potential risk:

1. The TT project may be terminated, one of the direct result is no return of the investment and may involved legal action.
1. May cause financial loses for both part for the TT transferor and the TT transferee.

Solution:

1. Build a better communication channel between the TT transferor and the TT transferee.
2. Set training course and work shop to get the staff to pay attention on the importance of TT.
3. Looking for the further: the advantaged technologies will eventually satisfy the business goals and gain market share.

1. As the sanitation project is for the rural peasant family, the training activities and main construction work should not set up during the harvest time.

3.4.4. Special finding 4

Researchers in project management, business people and academic text books all treat the experienced and skilled people's leaving (the term leaving in this paragraph means leaving for a better payment or promotion, not in any other person reasons) as a risk, however in the field research with 7 experience employees and 16 questionnaires in the YingKou Dechang sanitation product Ltd, it seems that the leaving of staff is not a risk – as most of them are declined for leaving. The reasons gathered from the field research is summarised as following:

1. The sanitation project in rural area is still in the early stage, the competition is not high like the financial or computing industry, there are very few position in the market that have a significant pay rise or promotion.
2. As the rural sanitation manufacturing industry is still in the setting up stage, most of manufacturers are located in different cities or provinces. The experience people who have many years of training, most of them are in their mid-30s or 40s, with personal reasons, they are not knee to work in another city/provinces with almost the same amount of payment but travelling every day.

There is the reason for one hypothesis that when the rural sanitation manufacturing industry in its developing stage, the staff leaving will become a risk for the TT in sanitation project, and the research and analysis of this particular factor will draw more attention.

3.5. Lessons Learned

There are nine key lessons from the China sanitation scaling up services during the past few decades, these are described as:

1. Need for Strong Leadership's Determination and Commitments: sanitation project is not just major technological and economic issues, but a major political issue. Previous experience has shown that the success projects have strong leadership's determination and commitments to improved rural water supply and sanitation not only at national level, but also at provincial and local levels.

2. Need for Simple and Clear Policies: Although there is no lacking of sectoral policies, rural water supply and sanitation scaling up services for the poor need simple and clear policy to suit China conditions. The centralized-decentralized policy, cost recovery policy, and capacity building at all levels policy have proved to be very effective in past scaling up services.

3. Need for Non-Complicated Institutional Arrangements for Leadership and Inter-Department Coordination

4. Need for Community Participation

5. Cost Recovery: Willingness to Contribute Financially: The full cost recovery policy within the affordability of rural residents has been well accepted by provincial, county, township governments, village committee, and rural residents.

6. Need for Capacity Building

7. Need for Technical Assistance: This results in increased productivity and high performances in connection with project implementation.

8. Need for Sharing of Knowledge and Understanding: Almost all successful and sustainable rural sanitation projects in China have the following key

characteristics: that there exist (a) a common view of sector development objectives and elements, and (b) understanding and support by county and township governments, village committees and rural residents.

9Need for Integration of Sanitation and Health Education: it is important to continue the emphasis on health and hygiene education, rather than physical sanitation investments only.

(Meng, Yao and Liu, 2004, p29-31, amended by Lin Liu)

3.6 Summary of the date analysis and finding

This chapter presents the finding of risks and the risk management solution that involved in the TT during sanitation projects. Generally the risks involved in TT in sanitation project are similar as the risks that occurred in any other industry/project, such as the risk in design, construction, engineering, management and investment. However with the policy and regulation of China's sanitation promotion plan, and the rural sanitation manufacturing industry is still in early stagy, the costs, timing or even skilled people's leaving haven't been a major risk for the TT process. However the transferee's skill capacity and the end user's feedback and reaction towards the sanitation project become the risks or potential risks to the TT in sanitation project. There are more research works need to be carried to analysis the risk management in TT in sanitation project in shandong province, and all the research work should have a close link with China's effective policy and financial support system on the promotion of rural sanitation project.

3.3 The risk analysis during the TT process.

The risk in Technology Transfer: Design

Risk Description	Source of risk	Drivers of risk	Score	Consequences of risk	Management solution	Score (Afte
The product design can not meet the requirement of the project or can not implement locally.	Changes in project scope	The market demand has changed. Such as the demand of new or better service	High	Investment failure	Upgrade industrial capacity in various aspects, such as design, planning, management skills.	Med
The length of time to accept the design and ideas is more than expect	Low absorption capacity of new technology	Lack of knowledge and skill	High	Project delay and increase project costs.	Provide training course and work shop in a regular basis, and set up examination-reward program, to encourage the study.	Med
The new design facilities, such as special tools or design software can not be adapted	Low design capabilities	Some special equipment may expensive and beyond the cost plan	Med	Product deficiencies, project delay and increase project costs.	Seeking for investment or funding.	Med
The staff are not technically qualified to use a equipment or software	Shortage of skilled staff	Lack of training	Med	Project delay and cost increased.	Provide training course and work shop in a regular basis, and set up examination-reward program, to encourage the study, or encourage the staff for self study or go to a part time course.	Low
The design may lose control when new technology comes out	Technology development and updating	Marketing competition and the rapid development of the technology	High	Both parties of the TT project lost confidence to continue the project. The current design and planning plane may be postponed or on hold.	Invest on the research and development, and try to find the solution to adapt the new technology	Med

The risk in Technology Transfer: Construction

Risk Description	Source of risk	Drivers of risk	Score	Consequences of risk	Management solution	Score (Afte
Reliability and availability of labour	Insufficient skilled staff	Lack of training	High	Slower process on site than anticipated, the costs increase	Provide training course and work shop in a regular basis	Med
Low-quality of material to use on site rather than expected	Hard or expensive to source the proper material	Local material can not meet the expectation	High	Slower process on site than anticipated, the cost increase	Procurement route and funding	Low
On-site safety	Lack the awareness of health and safety		Med	Accident and unhappy event happened, may cause the delay of the project.	Establishing health and safety policy and provide the relative uniform and equipment	Low
Strike of workforce	The dissatisfaction of payment or working condition	Lack of communication	Med	Project may slow down	Negotiation with the relative work unions	Low
The timeframe may be long to planning permission and acquiring the land	Government regulation to acquiring the land		High	Project may slow down	Under the regulation by the government, Both parties of the TT project must take the risk	Low
Disruption caused by protestors	The use of the land or the noise caused by the construction work	Lack of communication	Med	Project may slow down	Negotiation with the activists	Low

The risk in Technology Transfer: Engineering

Risk Description	Source of risk	Drivers of risk	Score	Consequences of risk	Management solution	Score (Afte
Chemical product is used	Need approval from the government	Government regulation	Low	Project may delay	More research work is needed to prepare for the data to the government to get the permission	Low
Chemical product is used	Hygiene and safety concern by the local people	The local people are not confidence by the use of the chemical and lack of the knowledge	Med	Project may delay, and the cost increases	Negotiation with the local people and publish the hygiene and safety promise, and provide conference or meeting with local people to demonstrate the use of the chemical	Low
High cost	Nature or material of the equipment or component	Certain equipment or component may need frequently cleaning or change	High	Cost increase for the end user	Keep updating the technology capacities	Med
Highly dependent on the operator skills and immediate availability of manufacture assistance (especially in the repair and maintain part)	More training is need.	The knowledge capacity is low	Med	Provide more train and material	Provide training course and work shop in a regular basis, and set up examination-reward program, to encourage the study, or encourage the staff for self study or go to a part time course.	Low

The risk in Technology Transfer: Investment:

Risk Description	Source of risk	Drivers of risk	Score	Consequences of risk	Management solution	Score (Afte
Interest to pay related to the length of the project	The project may delay	Lack of communication and co-operation in the project	High	Cost increase, project may fail by the lack of financial support	Sign the contract with the list of all the regulations and conditions before the start of project	Med
The potential discount rate to get	Lack of Financial analysis and negotiation	The cost of the project may increase	Med	The cost of the project may increase, may affect the long term working relationship	Financial analysis and negotiation	Low
Cash flow problem (Including bankruptcy, insolvency)	Lack of Financial analysis and negotiation	Financial problem	Med	Project may fail by the lack of financial support	Financial analysis and insurance and provide contingency reserves in project budgets	Low
Price fluctuations and inflation	Economy condition of the country	Economy condition of the country	Med	Cost increases	Financial analysis and cash flow management	Med

The risk in Technology Transfer: Management

Risk Description	Source of risk	Drivers of risk	Score	Consequences of risk	Management solution	Score (Afte
Contractual claim by contractor	Payment or dissatisfaction of the co-operation	Conditions of contract	High	Project delay, may have legal problem, and affect the long term working relationship	Contract clarification	Low
Lack of co-operation and communication in work	Mistakes, errors	Incompetence and misinterpretation	Mid	Not form a efficient team work, cause the delay of the project	Negotiation and build trust	Low
Demand and profitability below expectations	Delay to benefit realisation	Insufficient revenue returns.	High	Cost increase, project may fail by the lack of financial support	Financial analysis, strategic planning, and marketing promotion	Med

Chapter 4. Conclusion and recommendation

This report starts with introduction to present the background of the research work.

The second part of this report is Literature Review. This report first outlines the nature and role of TT in Shandong province's sanitation projects. The TT has all the nature of the project, this transferring process involves the transfer of the technology and knowledge, and financial activities and good communication become the bridge between technology transfer and technology transferee.

In a project or any other business activities, unexpected events happened all the times, and it is very often that things won't turned up as originally planned, there is a need to identify the risk and risk management involved it, and this role also apply to TT.

This report then describing the concept of risk and uncertainty, and explain the nature them. A brief of general risks faced by technology transfer has been introduced, this part act as the theoretical guide to the field work in Shandong province.

Risk management is the process of Identify & classify the risk, analyse the risk, respond to the risk, and monitor the consequence of the risk. It is the fundamental process the solve the risks, It is a fundamental part in the project management cycle, and need to review it before start a project and is very important in TT during sanitation projects, as TT is in the high risk category.

The next chapter is the empirical finding and analysis based on the field research in Shandong province, China. In the second of the report, with the theoretical guide, the general risks in TT in sanitation project is focus on the design, construction and engineering part. However with the field research, because of the special sanitation promotion policy and the current situation of the sanitation industry in china, the risks

finding is not 10% follow the theoretical guide in that chapter. As define the project risk, and present the risk management solution to reduce the risk is the necessary step to manage the risk, Chapter 4 presents a detailed explanation on why these special finding has been pointed out, and the general risk management solution to solve the problems. Recommendation to the risk management in TT in sanitation project in Shandong province, China:

- It is essential to set up a project risk management schedule/time table and adjust the plan regularly and new risks occur all the times.
- As Shangdong province is agricultural province, it is recommend that all the training activities and construction work should not set up in the harvest time, so it is important to start the risk management process as eerily as possible to allow time for any failure recovery and avoid disappointment.
- Have a close focus on the high risks activities, also keep a close monitoring on the potential risks
- Appoint the best project management risk team with a leading edge risk manager to work on the time and cost tasks, and pay highly attentions to the risks that may result in the termination of the project.
- Build an effective communication channel to be able to get the best assistance to deal with the high risks if any shortage of the staff.
- It is important organisation the project risk management early, however it is equally important to organisation the project early, as some of the construction works in the sanitation project need to get the permission from the government.

- Set up a professional risk recording and documentation method for further reference, which will save the time and efforts.
- Identify and monitoring the key risks in TT process, especially it involved a completely new product or design without a sufficient time of testing.
- When transfer the design skills and knowledge, try to use a relatively low cost material to make a model for primary review and assessment.
- TT is transfer the advantage technology to an transferee with relatively lower understanding of the knowledge, however if the transferee has been working in the same industry, it is recommend that to get the maximise usage of the technology or equipment they currently have, or try to focus on the product alternation if it is possible to reduce the costs.
- Sign a detailed TT contract and state clearly of the period of the contract and the responsibility. Having said that there is need for a contract for a clearly time scale of the TT project, sometime the life tests of a design, product or equipment may need long time than expect, as it is important to have the adequacy of a particular equipment, product or design. In such a case, a long-term test process is essential to a certain sanitation project environment. And because of the long time-consuming nature of these tests, there is a need to present various risk management plan and methods to monitoring the any risks in the test time, because it may be the risk when the product, design or equipment in actual operational use.

Chapter 5. Appendices

Appendix 1

TT in sanitation projects in China in general:

A. Design, research and development, engineering work and construction, operate and maintains on:

TT 1: Wastewater treatment facilities and plants. Recycle and reuse wastewater. Central treatment facilities for municipal wastewater and garbage. Pipelines for water supply and drainage. Systems for garbage collection and transfer.

TT 2: Rural and urban sanitary toilets.

TT3: Combine methane building of new modes of energy consumption.

B. Research work on:

TT4: Project for sewage disposal and garbage treatment for key watersheds and regions. Project for nationwide development of sewage disposal and waste treatment facilities. Projects for environmental preservation at scenic spots. Projects on rural and urban sanitation. Step up piloting of dry eco-toilets to ease water resource strains in the course of accelerated urbanization.

C. Provide management and marketing promotion skills on:

TT5: Accelerate the commercialisation of the sewage and waste Treatment industry. Established market-driven operating system for wastewater treatment and waste treatment in a much larger context.

D. Education and training course on:

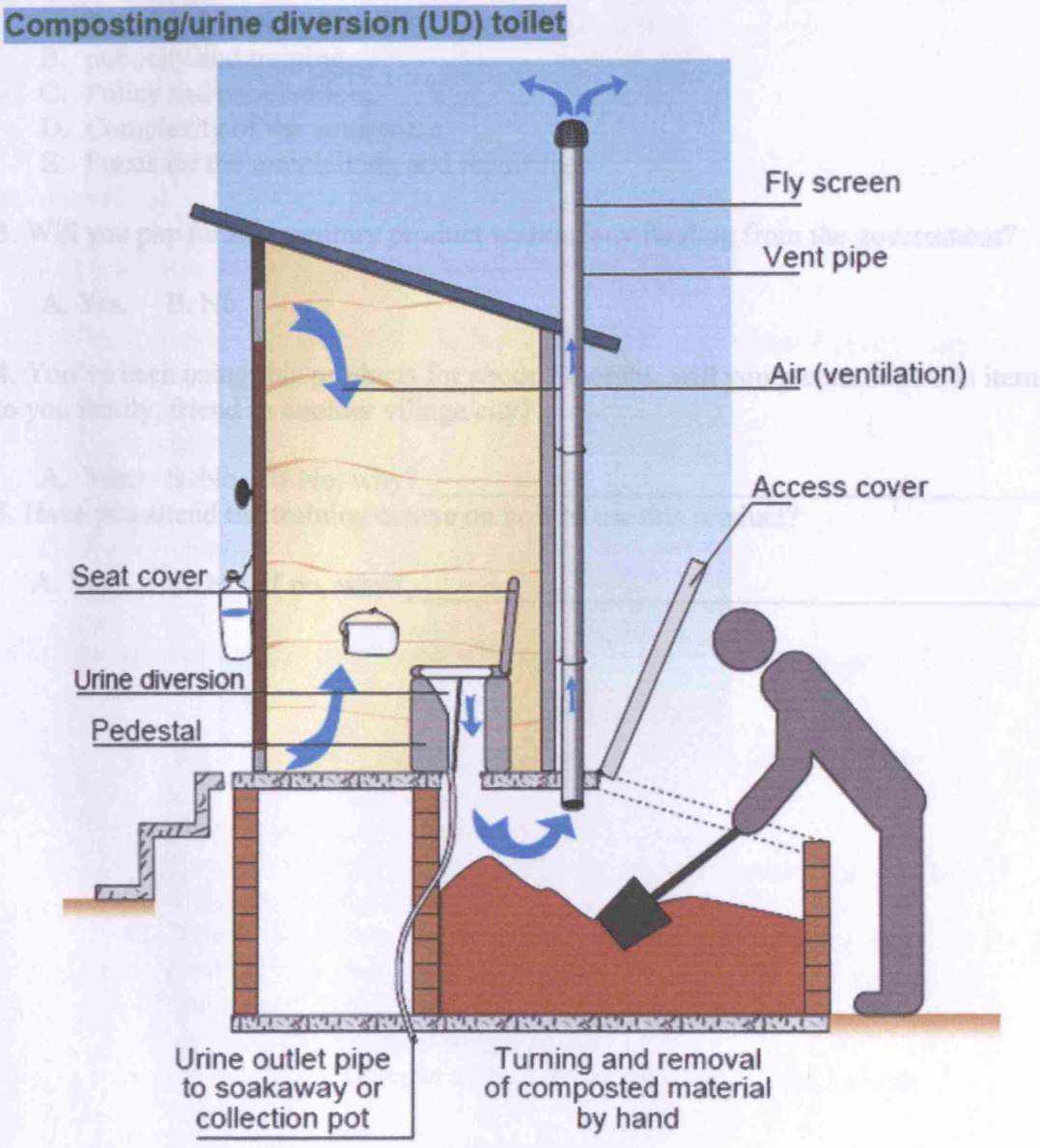
TT6: Hygiene course and standards for rural sanitation. Rural environment-monitoring networks and emergency-response systems. Sharing application of appropriate technologies. Environmental education and sanitation in schools to introduce advanced concepts and technologies. Provide training course for the people who are working on the sanitation projects.

(Source: Sanitation Country Profile – China, 2004, edited by Lin Liu)

Appendix 2.

Composting /Urine Diversion (UD) Toilet

Source: Sanitation for a health nation, 2002, P5.



Appendix 3

Questionnaire to the Peasant farmer

1. Have you heard of sanitary latrine?

   A. Yes. B. No. If yes, When_____

2. What is your most concern on using this product? Please only choose one answer.

   A Rebuilding latrine,
   B. publicity and training,
   C. Policy and cooperation,
   D. Complexity of the equipment
   E. Funds for the maintaining and repair fees

3. Will you pay for this sanitary product without any funding from the government?

   A. Yes. B. No

4. You've been using this products for about 7 months, will you recommend this item to you family, friend in another village/city?

   A. Yes. B. No. If No, why?_____

5. Have you attend the training course on how to use this product?

   A. Yes. B. No. If no, why?_____

Appendix 4

Interview questions and questionnaires to the employees in YingKou Dechang sanitation product Ltd.

Questionnaire to the employees in YingKou Dechang sanitation product Ltd.

1. Please list 5 risks and effects you face when you take part of this TT project.

2.Have you ever considered leaving the company? (Questionnaires with this question are only send to the design and development department)

A. Yes. B. No. Please state your reason for the answer.

3. Please comment the training course and material you received from you technical transferor?

4. How often you attend the training course? Please state.

5. You've been working with your technology transferor for about 4 years, please state your working relationship.

A. Good and friendly
B. Just normal
C. I do not like to work with them
D. No comment

Interview questions to the employees in YingKou Dechang sanitation product Ltd.

1. Why risk management is important for your organisation's TT activity?
2. What is you most concern on the TT project?
3. How did you handle the risks on training the construction work to build the sanitary latrine?
4. If there are claims from your customer about the quality of you product, how did you share the responsibility with you technology transferor? (This question is only asked to the CEO of YingKou Dechang sanitation product Ltd.)
5. Do you have the problem that the product doesn't fit the local condition?
6. What is your risk management process?

Appendix 5

Interview with project managers in Shandong sanitation project.

1. How did you know YingKou Dechang sanitation product Ltd and choose them as your product supplier?
2. What is you role in the TT on the sanitation project?
3. What is you risk management process?
4. Please list 3 risks and effects you faced in the TT during sanitation project.
5. If the peasant farm is not satisfied with the quantity of the product, how can they make the complain?

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