Studies on Preventing Outbreaks of Problem Projects in the IT Firm

IT 事業分野における問題プロジェクト発生防止に関する研究

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Abstract

IT (Information Technology) applications have evolved from tools for limited use at the beginning to infrastructures for the social and economic activities at present and much more IT applications are expected in the future. However, when we focus on IT development projects, we often observe problems related to the IT projects, such as piling up of the social and economic activities owing to IT defects, problems caused by magnificent overruns of IT development costs and delays of IT service launches, which cause opportunity losses.

By the way, the Project Management Institute (PMI) developed a project management standard PMBOK (Project Management Body Of Knowledge) at 1996 for projects to achieve their planned goals of quality, cost and delivery (QCD) with more certainty. The PMBOK has been utilized for projects in various application areas including the construction firm and the chemical plant firm. The PMI has continued to enhance the PMBOK since then and the current edition of the PMBOK occupies a position of a virtual common standard which is also applicable to the IT firm. However, since application specific knowledge is not assured to be involved in the PMBOK, it is required for each firm to compliment individual specific knowledge. In spite of the request, it is difficult to say that the IT specific knowledge is sufficiently generalized and systematized, since, although some practical professionals have described their knowhow regarding the IT specific knowledge in their books, they are based on individual experience of each author and lack sufficient cases for the proof of their idea.

However, even after the PMBOK has gained popularity, it is difficult to say that interruptions of problem projects, which failed to achieve planned QCD, can be hardly observed in the IT firm. This may be the future threat to increase bad influences to the social and economic activities.

The objective of the thesis is to prevent outbreaks of the problem projects and the author tries to systematize the IT specific knowledge or to derive methods or tools for the objective by using objective evidences based on cases obtained from professionals in the IT firm. Specific contents in the thesis are described as follows.

Chapter 1 clarifies backgrounds of the researches including the history of the progress of the project management and a bird's-eye view of trends of IT applications to the social and economic activities. It also clarifies the target of the researches in the thesis by specifying negative influences caused by the problem projects due to the project management for developing IT systems.

Chapter 2 shows that the following subjects are particularly required to be solved from a viewpoint of preventing the negative influences to the social and economic activities, by literature reviews related to the IT specific knowledge.

Subject1) To systematize the IT specific knowledge for the project manager (PM) to achieve planned goals of the QCD of general projects in the IT firm with more certainty,

Subject2) To clarify responsibilities of stakeholders regarding serious problem projects (SPPs) which cause magnificent influences to the social and economic activities, by using actual SPP cases,

Subject3) To derive a method to identify earlier phenomena that alert risks of occurrences of the SPPs (major risks), while there are too many other phenomena which do not cause the SPPs.

Subject4) To develop a manageable dependability model, which clarifies the management responsibility of the total dependability of the IT services regarding the increasing threat of IT accidents which may cause significant negative influences to the social and economic activities in the future.

Chapter 3 corresponds to the Subject1). Focusing on filed IT projects, we systematize the tacit knowledge of PMs who have never failed to achieve goals of the QCD in general IT projects. We also formalize the knowledge as tools for PMs in the general IT projects to easily introduce the method, and evaluate the method by applying them to actual IT projects.

Chapter 4 corresponds to the Subject2). Focusing particularly on customers, senior managers and sales persons among stakeholders, we clarify how they have related to IT problem projects by analyzing cases of actual IT problem projects and we also suggest practical examples of countermeasures for the stakeholders to achieve their responsibilities.

Chapter 5 corresponds to the Subject3). We focus on the SPPs which may occur even if the method described in the Chapter 3 is introduced. We also propose a model to describe the growing process of major risks, which cause the SPPs, by using cyclic causal models. We next derive a method to identify earlier the major risks in the IT firm, by analyzing the relationships between the model and the actual SPP cases.

Chapter 6 corresponds to the Subject4). We discuss a manageable model to clarify the management responsibilities of the total IT service dependability and also evaluate the model by using actual IT accident cases.

Chapter 7 summarizes the above results and presents further researches and shows how to move forward.

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Chapter 1

Introduction

1.1 Backgrounds

1.1.1 Progress of Modern Project Management and What Unfulfilled

A responsible organization which should achieve a mission such as constructing a building or developing a new medicine is generally called a project. Hereafter, necessary information regarding the project to which the thesis pays attention are explained first shortly based on terminologies of the PMI (Project Management Institute), and the history and the current status regarding management technologies for the project are outlined.

Every organization such as a company, a governmental agency or an association has business activities. The organizational activities are classified to operation activities and project activities. The operation activity has two characteristics, ongoing (endless) and repetitive (repeating the same business processes). On the other hand, the project activity is defined as a temporary endeavor undertaken to create a unique product or service. Temporary means that every project has a definite beginning and a definite end. Unique means that the product or service is different in some distinguishing way from all other products or services. Since there are risks due to the characteristics of temporariness and uniqueness, the project deals with missions with the risks, which the operation activity cannot achieve.

"Project management" is the management to accomplish unique missions with risks in projects. On the other hand, "administration" deals with conducting achieving operation activities such as repetitive works using manuals and it is mainly practiced in a classic functional organization. Since the two terms resemble each other and both are translated to the same word *Kanri* in Japanese, we call *Kanri* regarding project "project management" to distinguish them clearly.

Repetitive operation missions in functional organizations involve relatively less risk and the organizations dare to avoid risks. However, if the organizations are pressured to meet with new requirements due to environmental changes such as diversification of requirements and achieving cost competitive structures, unique missions appear and risks accompanied with achieving the missions become higher. If taking risks is essence of economic activities as Drucker says in "The Practice of Management" [1-1], we cannot escape from growing risks due to progress of economic activities. Thus, it is said that enterprises tend to restructure the risk-averse functional organizations and instead introduce the project management, which positively tries to control risks [1-2]. Consequently, it is thought that importance of the project management technologies may become larger year-by-year.

The project management technology before 1980s had been targeting only to managing planned QCD (quality, cost and delivery) and mainly relying upon intuition, experience and courage (*Kan*, *Keiken* and *Dokyou* in Japanese respectively) of a responsible project manager (PM). We call such management method the KKD, summarizing the initials of the Japanese three words. Since the method was largely depend upon skills of PMs and major way of looking at the method was to understand that it was capability rather than technology, few person paid attention to the method as one of targets in scientific researches.

However, after 1990, on deficit financing of US governmental agencies, there begun to be observed activities of researching more scientific project management technologies including EVMS (Earned Value Management System) [1-3], which could provide and share status information including cost and progress of projects by using objective measures. Actually the EVMS was introduced to projects for the US governmental agencies including DoD (Department of Defense) and contributed to improve the national finance.

The PMI published the PMBOK (Project Management Body Of Knowledge) [1-4] as a scientific method including the EVMS and systematized project management knowledge from wider points of views in the book at 1996. Due also to the year-by-year growth of recognition of the importance of the project management technologies mentioned above, this book begun to be recognized as a common knowledge system, which can apply not only to the construction firm or the engineering firm but also widely to the other firms including the finance firm [1-5].

The PMBOK systematized the project management knowledge necessary for

PMs by the following nine knowledge areas which involve the quality management of ISO9001 [1-6] as an element.
1) Scope management
2) Time management
3) Cost management
4) Risk management
5) Procurement management
6) Human resource management
7) Communication management
8) Quality management
9) Integration management

The PMBOK also categorized the project lifecycle to five phases including initiating, planning, executing, controlling and terminating, and defined necessary knowledge of the integration management to control the total project.

Such a method is called a modern project management (MPM) [1-7] to distinguish the classical method based on the KKD which only covered the QCD. Since 1996, the PMBOK has been revised every four years [1-8] [1-9], and the current edition [1-10] is recognized as the actual standard shared by various firms including the IT (Information Technology).

Although the PMBOK is difficult to understand because management processes are defined in each knowledge area and are not described in each phase from initiation to termination, whose style is familiar with actual PM, the PMBOK gained the worldwide popularity. One of the reasons might be that there have been published a book which explains risk management specific processes from initiation phase to termination phase [1-11], an explanatory booklet for actual works in field projects [1-12] and other many supplemental books which explain the system and the theory of the PMBOK in plain terms [1-13] [1-14].

Figure 1-1 illustrates the area where the PMBOK actually covers. Although it covers knowledge unique to project management, some part of the PMBOK overlaps other management disciplines. The PMBOK suggests using also existing enterprise management knowledge which corresponds to knowledge unique to *general management*. Focusing next on *application areas*, application specific knowledge is not assured to be involved in the PMBOK, since the basic role of the PMBOK is to cover the common knowledge for every application area. Therefore, it is thought for PMs in each application projects are suggested to practice their project management by complimenting necessary application specific knowledge.

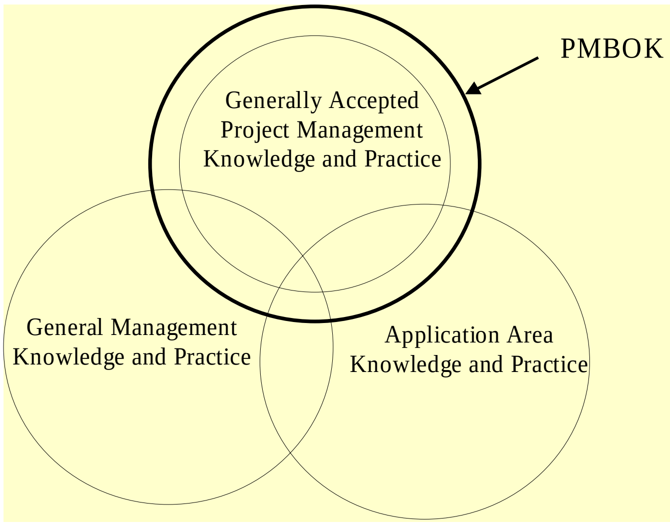


Figure 1- 1 Applicable area of the PMBOK

Although there are other activities than PMI, which try to provide different project management knowledge systems by defining their own MPMs as mentioning later, any of these knowledge systems obtained less popularity than the PMBOK in the world. In any management knowledge system, it is required for PMs to practice their project management by complimenting necessary application specific knowledge. To cope with it, extensions for the application specific knowledge of some firms including the construction can already be seen [1-15] [1-16].

However, as far as the IT specific knowledge is concerned, we cannot observe the progress of the MPM research outcomes as same as the extended version for the construction firm.

1.1.2 Spread of IT to the Social and Economic Activities and Its Foundation

Remarkable progress of the IT technology can be observed since 1946 when ENIAC [1-17] was developed, which is said to be the first computer in the world. Major application of computers in the early stage was the EDP (Electronic Data Processing) which took place of manual procedures for large scale numerical calculations. After that, not only batch processing but also online services connecting telecommunication facilities from computers to terminals such as ATM (Automatic Teller Machine) were realized. This contributed to improving efficiency of business by taking place of partial enterprise business processes including those of tellers in banks. Computers were also applied to some portion of the management process such as the management support and the decision making by systems such as the MIS (Management Information System) and the DSS (Decision Support System).

From 1980s, general business offices begun to accept so called OA (Office Automation) by introducing personal computers. From 1990s, there can be observed increase of the integrated management systems where work stations in departmental offices and mainframe computer systems of companies were combined. The computer systems of companies also begun to connect another computer systems owned by different companies based on standards such as EDI (Electronic Data Interchange) [1-18] or CALS (Continuous Acquisition Life-cycle Support) [1-19]. These new applications brought an era of the EC (Electronic Commerce) which is a commonplace at present. Furthermore, after the internet appeared after the disclosure of technologies of the ARPANET [1-20], which had been restricted to national defense use, data exchange services using the internet begun to increase due to the new technology WWW (World Wide Web).

Before the era mentioned above, most of IT systems are thought to be convenient tools. That is, IT systems composed by computers and the internet took place of partial business process in companies. Thus, there seldom could be observed cases where IT systems had significant bad influences to the social and economic activities, since even if IT systems did not work due to some accidents, there were alternative measures including manual workarounds.

However, after 2000, due to the drastic growth of the internet in the world accompanied with the appearance of the Web2.0 [1-21], we can observe new application styles, such as internet banks or internet bill brokers, where the IT including the internet took place of most of total business processes or even physical offices of the companies. The IT also begun to spread to general consumers by implementing embedded software in family devices, such as mobile phones, DVD players and car navigators. It is said that the current IT services occupy just a small part of the expected total services and further more and more extension of the IT applications will continue in the future [1-22].

Of course, the success of developing IT systems requires efforts of professional members of various IT technologies in projects for developing the systems. However, it is thought that the success of such expansion of IT services mentioned so far could not be realized, if another professionals, who control the professional members in the projects and has responsibilities to achieve planned QCD of the systems, could not achieved their responsibilities.

The professionals are the PMs. When further more applications and extensions of the IT to the social and economic activities continue, it is also thought that success or failure of such applications and extensions depends on the management of the IT projects. In other words, it is thought that the role of the project management as a foundation for such progress of the IT will become further more important from now.

1.2 Target of the Research

1.2.1 Troubles Related to IT Project Management

Even after the MPM gained popularity, it has been reported that interruptions of problem projects, which failed to achieve planned QCD, can hardly be observed in the IT firm [1-23], comparing with other firm including the construction. There also can be observed no report that the situation of the IT has been improved so far.

If the problem projects occur in the IT firm, the influences of them take various shapes and spread widely to various peoples or organizations. This can be observed from 193 cases of IT problem projects covered by Information-technology Promotion Agency, Japan [1-24] [1-25] [1-26]. The examples of the influences are described below by categorizing several stand points such as public users who are offered IT services, IT user companies who offer services by using the IT, IT vendor companies who develop IT systems and the total IT firm.

1) Public users who are blessed with IT services

Since the human dependency to the IT may increase, it is concerned that greater negative influences to the social and economic activities may occur in the future, when IT systems suddenly do not work or public users are obliged to stop using expecting IT services due to IT accidents [1-27].

Particularly from a viewpoint of PMs who are responsible for constructing IT systems, the project management is expected to involve great difficulties and risks to meet with the increasing and diverse demands of developing the IT systems. Because they concern whether they really can keep developing stable IT systems, which should not cause such negative influences to the social and economic activities, only by using existing resources and methods.

The Ministry of Economy, Trade and Industry, Japan (METI) summarizes recent cases of IT accidents which are broadcasted by Japanese news media regarding accidents of IT systems related to firms of important infrastructures which provide social and economic infrastructures such as finance, telecommunication or transportation [1-28]. Approximately 70% of the cases are caused by the defects of the IT systems. Trends of the number of IT accidents from July 2005 to July 2009 [1-29] are shown in Figure 1-2. It is becoming a greater threat for the safe and secure society, which depends on the IT, that public users cannot use IT services due to increasing IT accidents in spite of the spread of the IT applications to the social and economic activities.

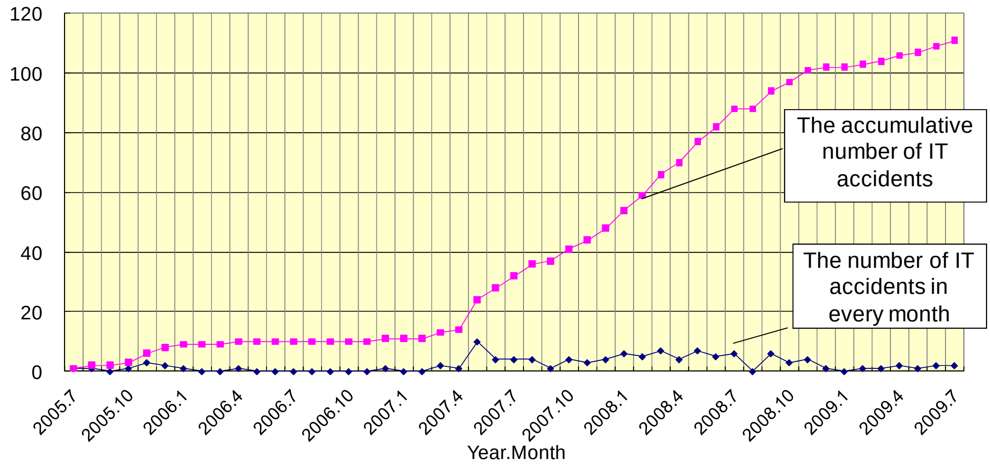


Figure 1- 2 Trends of the number of IT accidents broadcasted by news media in Japan

2) IT user companies who offer services by using the IT, including public corporations and service corporations of finances and electric powers.

For instance, when a power failure, which occurred at the northeastern part and the middle western part of the USA at 2003, was caused by an embedded IT system, it consumed approximately 40 to 50 million dollars for completing the complicated recovering processes. It is pointed out by the METI that various kinds of system disasters may occur due to IT accidents and they sometimes cause magnificent influences to the society in the future [1-30].

Moreover, when IT projects cannot achieve the planned goals of launching IT systems, the following influences can be observed often within the companies.

- Information system division

The delays of the IT systems need increasing of man powers in the IT user companies. Since resources of engineers who have necessary skill are usually limited, it sometimes cause another delays of the other IT systems.

When the newly developing IT systems are planned to replace old IT systems, additional fees for expanding periods of maintaining hardware or software products are necessary for prolonging lives of the old systems. However, if the migrations of the systems are planned at the end of maintenance time limits of the old products, the delays of the new systems cause risks where defects of the old products cannot be fixed if they happen after the maintenance time limits.

- Sales division

It is probable that there may cause magnificent opportunity losses, if the sales division solely depend their sales processes for acquiring orders of their products.

- The management

Since the abnormal operation of the mission critical IT system for a long period affects the social trust of the company, it sometimes causes changing members of a board of directors in the companies. Moreover, in the cases of companies whose businesses are completely depending on IT systems such as companies for internet banking, the delays of the IT systems' launch sometimes decide life or death for the companies.

3) IT vendor companies

In IT vendor companies including information system integration (hereafter, SI) companies, the followings can be observed very often, if the problems of the delays or the defects of IT systems come to light around the time when the IT systems are planned to be launched.

- Profit loss

It is probable that there may cause profit losses due to additional cost for the problem projects. Moreover, if the user companies require the vendor companies to compensate for their losses corresponding to their additional cost and opportunity losses, it is also probable that the profit losses of the vendor companies increase much more.

- Influences to human resources

Members in the problem projects keep working hard as far as they have strength left to recover the problems of the delays or the defects. Even if they succeed the recovery, it is probable that the vendor companies lose some of the project resources due to the resignations or the illnesses of the members.

4) The IT firm

The jobs of the IT firm, where problem projects can be often seen, were called "3K" by summarizing the initials of the Japanese 3 words (*Kitsui, Kaerenai* and *Kibishii*, which means hard, difficult to go back home and severe respectively). However, the Japanese news media call the jobs of the IT firm like "7K" or "13K" by increasing the "Ks", which include *Kekkon-dekinai* (have not enough time to get married) or *Keshou-ga-noranai* (lady's makeup has come off) [1-31]. The top managements of the Japanese IT firm take this as a serious problem since this may make the rate of economic growth of the Japanese IT industry slower compared with the growth of IT industries of India and China [1-32].

5) Summary

Bad influences caused by the above problem projects can be summarized from a view point of affects to social and economic activities in the long term as follows.

The problem projects cause bad influences not only to economic activities of vendor or user companies in the IT firm but also to general social activities or economic activities in firms other than the IT firm, due to failures of IT projects to achieve their planned goals of QCD. Moreover, if IT projects will not be able to acquire enough resources of project engineers because students might become to keep away from applying their jobs for the IT firm in the future, forcible initiations of IT projects neglecting the resource shortage might be another possible causes of new problem projects.

Thus, we should understand that the problem of problem projects is not just a temporary issue but also one which might continue causing bad influences to the social and economic activities in the long terms.

1.2.2 Focus of the Research

As discussed before, the project management is thought to have a role of laying one of the foundations for the IT to spread widely to the social and economic activities. However, the MPM that PMs in the IT firm can use is restricted to the common knowledge part shared by firms other than the IT. If the PMs cannot use scientifically generalized or systematized methods in the IT specific knowledge part, whether projects may success or fail depend on the legacy method of the KKD.

Actually, most of persons in field IT projects think that there may be no way except depending on the KKD, since they can seldom obtain scientific methods for project management in the IT specific knowledge part. There can be still observed some researchers who find less research subject for the IT project management and give up treating them as the target of scientific researches. That is, it is difficult to say that all of the industry and the academia are struggling to develop countermeasures to cope with the problem.

However, if they keep thinking so, problem projects may be apt to occur in the IT firm and may become a threat to cause various bad influences to the social and economic activities also in the long terms as mentioned before. We cannot expect reducing the amount of such threat if we still keep depending on the KKD.

Thus, we dare to focus on the IT specific knowledge in this thesis. We also identify specific parts among the IT specific knowledge which are difficult to understand scientifically and try to systematize or generalize them using objective evidences.

Moreover, it is important for us to move forward the researches to a sound field of researches, which both of the industry and the academia recognize its importance. Because this may prevent the occurrence of problem projects in the IT firm with more certainty, and consequently strengthen the foundation from a viewpoint of the project management to meet with the further requirements for the IT to spread to the social and economic activities in the future. In this sense, suggestions for moving forward researches in the field are required. Therefore, we also pay attention to figure out such suggestions derived from objective evidences in the thesis.

Chapter 2

Research Subjects and Organization of the Thesis

For deeper discussions of the thesis based on the viewpoint mentioned in the former chapter, we first clarify a bird's-eye view of the IT specific knowledge by reviewing legacy researches. Next, after investigating current status of more concrete technologies related to the IT specific knowledge, we identify research subjects which are not sufficiently generalized or systematized among the technologies. Furthermore, we summarize the subjects and also discuss about the features and an organization of the thesis.

2.1 Review of Legacy Researches and Subjects

2.1.1 Bird's-eye View of the IT Specific Knowledge

Okamura classifies the necessary knowledge for constructing or providing IT systems to information processing technologies, technologies related to the software engineering and management methodologies related to IT systems [2-1]. In this thesis, we classify the knowledge to 4 categories by adding management methodologies in the enterprise organizations to which IT projects belong, by considering the growing influences of the IT to the social and economic activities as mentioned in the former chapter.

(1) Information processing technologies

From a view point of products, there are technologies for elements that configure an IT system such as the hardware, the operating system, the data base and the programming language, which belong to this category.

(2) Technologies related to the software engineering

The technologies are derived from a viewpoint of developing IT systems. Although the software engineering sometimes involves the project management methodologies for developing IT systems, the term of the software engineering in this thesis is used as a narrow sense of the IT developments where the management methodologies are excluded.

(3) Management methodologies related to IT systems

Other than the PMBOK which covers the project management knowledge system, the systematized knowledge of the best practices for developing IT systems also belongs to this category.

(4) Management methodologies in the enterprise organizations

Compared to the PMBOK for projects, this category includes the management knowledge system for programs (organizations to which the projects belong) or methodologies to evaluate the organizational maturity.

The information processing technologies (1) are offered for engineers such as programmers, application designers or engineer of infrastructures for IT systems. As it is well known, the technologies in this category have been significantly improved in view points of reliability, performance, cost and architecture by scientific approaches. We can expect further progress and renewal of the technologies continues contributing to improve the QCD of IT developing projects.

The technologies related to the software engineering (2) correspond to software engineers or system engineers. Before around 1975, it was thought that the technologies largely depend upon skills of engineers, and major way of looking at the technologies was to understand that it was the capability. Few scientist paid attention to the technologies as targets of scientific researches just like few scientist viewed the project management methods at the early stage. However, after Boehm proposed a concept of the software engineering at the IEEE paper [2-2], the inefficient software development begun to be considered as major problems. Thus, generalized methodologies of developing systems for higher productivity begun to be strongly required and numbers of proposals concerning the technologies have been proposed so far. For example, technologies such as software development methods [2-3] [2-4] including the Structured Design by Stevens, the Structured Analysis by DeMarco [2-5] and the Composite Design [2-6] were the major outcomes and became the foundations for the software engineering. Particularly, a remarkable progress concerning the Structured Design has been observed after that. Owing to outcomes of the CASE (Computer Aided Software Engineering) tools, it became possible to develop the structured diagrams, which is necessary for structured analysis. These technologies became to be also applied to develop large-scale on-line systems after 1990s. Moreover, by introducing the systematized method for educating engineers [2-7] and system developing methods based on the data modeling, there can be observed not only research outcomes regarding restructuring systems [2-8] [2-9] for the systems to meet quickly with environmental changes of the management, but also the progress of introductions of the outcomes to actual systems [2-10]. Consequently, it is thought that the software engineering, which was thought just as the capability 35 years ago, has sufficiently matured evolving to the scientific research domain.

The management methodologies related to IT systems (3) include the management by PMs and the management methodologies in the enterprise organizations (4) include the management practiced by senior managers (including directors of business headquarters or the management executives) in organizations to which the PMs belong.

It is possible that the PMs or the senior managers are much more related to the occurrence of the problem projects in this thesis than engineers mentioned in (1) and (2). Moreover, since researches regarding (3) of the management methodologies related to IT systems and (4) of the management methodologies in the enterprise organization have less research history than researches of (1) and (2), it is expected that there might be found important subjects to be solved scientifically in the domains of (3) and (4). There fourth, we proceed to investigate more details by paying attention to (3) and (4).

2.1.2 Current Management Methods Related to IT System and Their Subjects

We have the management methodologies related to IT systems excluding the PMBOK as follows.

1) ITIL [2-11] [2-12] [2-13] [2-14] [2-15] / ISO20000 [2-16]

ITIL (IT Infrastructure Library) and ISO20000 summarize the best practices in the IT firm and are applied to management activities in the maintenance and operation phases. Development activities in the maintenance phase are close to repetitive operations rather than project activities. Moreover, the development activities in the maintenance phase are generally said to involve lower risks of not achieving planned QCD than the activities to develop new systems in the development phase. Thus, the term of the management in the ITIL and the ISO20000 is rather used in sense of the administration and there can find few discussion of the management in the project management. Consequently, we cannot find any discussions to prevent occurrence of problem projects in the IT firm, which we are focusing, in these documents.

2) CMMI [2-17]

CMMI (Capability Maturity Model Integration) also summarize management processes as the best practices but is applied to the development phase. The management processes include not only processes similar to the ITIL/ISO20000 such as the configuration management but also additional processes necessary in the development phase such as the project planning. The CMMI systematize such best practices of processes and gained the popularity in the world.

However, the CMMI has the following problems when we consider introducing it to the management practiced in the IT firm.

- Insufficient explanation of the management for PMs in prime contractors

We compare the document of the CMMI and the PMBOK, a representative MPM. The PMBOK describes detailed processes of the project management in its 9 knowledge area. On the contrary, the CMMI describes the processes simpler and emphasize on achieving requirements in editorial aspect.

For example, as for the project planning, the PMBOK shows specific processes and methods from initiation to termination are described in individual knowledge area corresponding to project baselines such as scope, cost and time. On the contrary, the CMMI recommends only executing process so that the project plan is written in the authorized consistent format and documents of the plan is well maintained.

It is almost the same as for the risk management. The CMMI requires only executing process so that a risk list is written in the authorized consistent format and the documents is well maintained. It does not describe specific processes from risk identification to developing responses to the risks, which are needed by actual PMs in prime contractors.

Thus, it is thought that the CMMI assumes its major application area to engineering processes practiced in the project environment involving less risk where the PMs do not have to develop project plans proactively. It is supposed to correspond to IT projects in lower sub contractors which make programs or execute unit test in the Japanese multi-contractors' organization.

However, if the situations of the PMs change from sub-contractors to the prime contractor, they have to develop the project plans proactively. They also have to manage higher risks than those in sub contractors. Consequently, it is difficult to think that the CMMI provides sufficient explanations for such PMs in prime contractors in the IT firm.

- Unclearness of the total knowledge system for the project management

The CMMI does not clarify the IT specific management knowledge needed for prime contractors by comparing its knowledge with the existing 9 knowledge area of the PMBOK. Consequently, it becomes difficult for PMs in the prime contractors to understand the total system for the project management in the IT firm, when they use not only the PMBOK but also the CMMI..

3) The MPM methods excluding the PMBOK

For PMs in prime contractors, there are many project management methods other than the PMBOK. For example, IPMA (International Project Management Association) [2-18] has its own standard named ICB (IPMA Competence Baseline) [2-19] and AIPM (Australian Institute of Project Management) recommends NSCPM (National Competency Standards for Project Management) [2-20]. While the PMI developed a certification system for the project management professional, which is well known as the PMP, the IPMA and the AIPM have their own certification systems for PMs. Although IT companies also tend to have their own certification systems by introducing their own evaluation criteria for PMs, most of IT companies in Japan recognize the PMP as a base for their evaluation systems [2-21] [2-22] [2-23] [2-24] [2-25] [2-26], since the PMBOK is much more popular than the other methods in the IT firm. Such strong supports to the PMBOK have raised the number of the PMP holders more than ten times in nine years from 2000 to 2009 [2-27]. On the other hand, it is difficult to think that the other methods including the ICB and the NSCPM have not gained sufficient supports from the world, since their certification holders have not increased as much as the PMP.

Moreover, since any of the MPM methods require PMs to practice their management by complimenting necessary application specific knowledge, they do not focus on the IT specific management knowledge and do not generalize or systematize it.

4) Books and researches for prime contractors in the IT firm

There are books and research articles for prime contractors in the IT firm as explained below.

As for the books, there are many explanatory booklets which lead easy understanding of the PMBOK by showing correspondence of the individual knowledge of the PMBOK to the individual practice of projects in the IT firm [2-28] [2-29] [2-30] [2-31]. However, these stay discussing within the scope of the PMBOK and fail to clearly point out the IT specific knowledge which the PMBOK do not have. As for discussions beyond the scope of the PMBOK, there are other books that suggest specific lessons learned from based on cases of the authors' experiences as practical professionals [2-32] [2-33] [2-34] [2-35]. However, although they discuss beyond the scope of their experiences, it is difficult to say that they are sufficiently generalized to apply them widely to general IT projects, since it is difficult for them to acquire sufficient cases as evidences for the proof of the generalization. It is also difficult to find the total systematic shape of the management knowledge required to PMs in the IT firm, by summarizing the PMBOK and the IT specific knowledge.

There are also several research articles including discussion about the leadership of PMs [2-36]. However, since most of their discussions are limited to the narrow scope of some knowledge area such as the human resource management, few discussions can be seen which cover all of the 9 knowledge areas [2-37]. We can see some research articles which cover all of the 9 knowledge areas including discussions about assessing the project management maturity for the IT firm [2-38]. However, they do not show the total systematic shape of the management knowledge including the IT specific knowledge. Moreover, we hardly can see their practical results in actual IT projects, since their researches do not proceed to provide tools which are actually used in field IT projects. It is thought that there may be two reasons why they cannot systematize the total knowledge for practice. One reason may be that these research authors have less practical experiences and the other is thought to be that it is difficult for them to acquire sufficient cases as evidences for the proof of the systematization.

Based on the discussions so far, it is difficult to say that the IT specific knowledge has been identified and we can find specific shape of the total management knowledge including the PMBOK, which is needed for PMs of prime contractors in the IT firm. In short, we describe the subject of the legacy methods as follows.

- *The management knowledge is not systematized for PMs of prime contractors in the IT firm with tangible shapes of practical methods.*

Moreover, even if the general management knowledge of a veteran PM of the prime contractor in the IT firm is available, it is not easy to identify problem projects. Particularly it is difficult to identify a serious problem project (SPP) which has magnificent influences to the social and economic activities, since the SPP is apt to come to exist through complicated and long causal chains of multiple causes which sometimes occur simultaneously.

To cope with this, methods to understand the project progress quantitatively are discussed aiming to identify problem projects. For example, there are researches such as the progress evaluation methods by applying the EVMS to IT projects [2-39] [2-40], the quantification method of the project progress status focusing on processes [2-41] and the method to evaluate project process by using quality metrics [2-42]. However, although they can be methods to be sure of existence of the problems, it is difficult to use them for earlier identification of SPPs, since these quantitative measures can be first available only from the lower phase or the last stage of the development when problems of defects or the delay already come to light, and they cannot be used at the time of the occurrence of SPP symptom. Since it may be too late even if countermeasures are taken against SPPs by using them, they cannot be sufficient methods for preventing SPPs.

In short, the legacy methods also have the following subject.

- *There has been no proposal of a method to identify the symptom of serious problem projects due to complicated causal chains.*

2.1.3 Current Management Methods Practiced by Enterprise Organization and Their Subjects

The enterprise organizations in the IT firm are classified to 2 categories; vendor companies which have responsibilities related to constructing IT systems and user companies which provide IT services. Management methods practiced by the organizations are described as follows.

1) Enterprise organizational maturity standard

While the PMBOK is a standard for PMs, the OPM3 (Organizational Project Management Maturity Model) published also by the PMI is a standard for enterprise organizations to which the PMs belong. The OPM3 defines the following stages of maturity for the organizational project management [2-43] [2-44].

-Initial stage; Project process unpredictable, poor controlled and reactive
-Stage1; Standardize
-Stage2; Measure
-Stage3; Control
-Stage4; Continuously improve

These stages are very similar to the CMMI. It is highly evaluated that the OPM3 shows “Best Practice” models which describe an ideal organization involved in prime contractors and its operation. However, although it is a method to evaluate outcomes of project governance from a viewpoint of the organization, it does not show how stakeholders including senior managers of PMs should prevent problem projects, what role and responsibilities they should take and what countermeasures or processes they should practice in the IT firm. There has been no report that it has been actually contributing to decrease the number of IT problem projects after its initial publication at 2003.

2) Enterprise organizational process standards

The PMI also have process standards for the program management [2-45] and the portfolio management [2-46] in the enterprise organization, beside the project management.

The program management is the enterprise management for achieving higher business performance by governing a group of plural projects and it is assumed to correspond to the management practiced by stakeholders including senior managers of PMs, who are responsible for business units in SI companies. On the other hand, the portfolio management involves the management to prioritizing project businesses, for efficient achievement of business goals such as sales and profits or acquiring new markets. This is assumed to correspond to the management practiced mostly by sales persons in the SI companies, who have to acquire SI orders from customers and achieve the business goals of sales and profits efficiently by targeting markets. It is highly evaluated that these try to define and standardize management processes other than project management process in the total enterprise organization.

The JPMF (Japan Project Management Forum) under the PMCC (Project Management Professional Certification Center, Japan) developed another organizational management system named the P2M (Project & Program Management) [2-47] [2-48]. The P2M is a Japanese trial to expand the scope of the project management to the management, which has been practiced by managers other than PMs, such as entrepreneurs and finance managers. The P2SM is thought to be an aggressive challenge aiming for business innovation.

The program management, the portfolio management and the P2M rather seem to be developed by applying systematizing methods of the PMBOK for projects to systematize knowledge for the upper organizational management of program or portfolio.

However, from a viewpoint of problem projects in the IT firm, any of them do not identify who is responsible for the problem projects and do not point out clearly what actual countermeasures should be practiced in the enterprise organization to prevent the problem projects.

It is difficult to think that the three organizational management methods cope with needs of the IT firm to decrease the number of the problem projects. Also there has been no report that the number of the problem projects decreased after introducing the three methods.

3) Researches tackling with problem projects in enterprise organizations of the IT firm

There can be seen several books which focus on problem projects in the IT firm and point out organizational problems such as less involvement of senior managers in IT projects [2-49] [2-50].

However, the OPM3 does not explain specific ways of the responsibility assignment among stakeholders including senior managers of PMs nor describe countermeasures against problem projects. The program management, the portfolio management and the P2M also does not discuss about what responsibilities stakeholders in organizations should take to prevent the occurrence of problem projects, which cannot be avoided in actual even when the PMBOK is used.

A possible cause of this may be that the problems pointed out by these books are not officially recognized by the authorized organization like the PMI, since the books lack the proof of the existence of the organizational problems. Actually, although there can be seen many suggestions based on their personal experiences, it is difficult to say that the suggestions are verified by using objective evidences in the books. It is also thought that they cannot move forward the suggestions to practical countermeasures for stakeholders in the organization, due to the insufficient identification of their responsibilities.

Based on the discussions above, the subject of the legacy researches can be summarized as follows.

- *Responsibilities of IT problem projects are not clarified among* *stakeholders based on objective evidences.*

4) Other organizational activities

In user companies which provide IT services related to the social and economic infrastructures, IT owners are responsible for the QCD of developing IT services. Among the QCD, problems of the Q (quality), which are equivalent to the outbreaks of IT accidents mentioned in the former chapter, is the most important, since they have negative influences not only inside the user companies but also widely to the society.

However, it is not easy to prevent accidents of IT services accompanied with the social and economic infrastructures, even if best practices were executed against the three subjects mentioned so far. The reasons for this are as follows.

- It is impossible to realize absolutely no faults in IT systems, just like it is impossible to assure no bugs in large scale software.
- It is still possible that the other causes including operation faults may cause problems of dependability (reliability from a point of view of public users), which are equivalent to IT accidents, even if the IT system faults are successfully decreased.
- Major responsibility of the dependability rests upon user companies rather than vendor companies. Thus user companies, which provide IT services associated with the social and economic infrastructure, need the project management to achieve higher dependability by take higher priority to the Q among the planned QCD in projects for developing IT services. The IT accidents are possible to occur if the management is not sufficient.

All of the organizational management methods mentioned so far including the OPM3 or the program management do not discuss about the management for the user companies to achieve such higher dependability. Thus, it is natural to think that the user companies have no way except keeping their traditional organization composed of several departments including the development department, maintenance department and operation department, and expecting each effort of the departments to improve the individual dependability element. In another words, it is assumed that they have a view of the dependability of the total IT service (dependability model) which is effectively the sum total of each department's efforts to improve its own individual quality measures. However, we cannot say that IT accidents are now holding steady as illustrated in Figure 1-2. Therefore, it is probable that this is caused by unclear responsibility of the total dependability of the IT services in the organization including the IT owners.

Based on the discussions above, the subject of the legacy activities can be summarized as follows.

■ *There has been no proposal of a manageable model to clarify responsibilities of the total dependability of IT services associated with the social and economic infrastructures.*

2.2 Subjects and Structure of the Thesis

2.2.1 Summary of Research Subjects

Widespread researches have been practiced vigorously regarding the IT specific knowledge as mentioned in the former section. However, the legacy researches have failed to cover the four basic subjects which are mandatory for preventing the occurrence of IT problem projects.

The goals of the thesis are to resolve the subjects. We summarize four research subjects corresponding to the basic subjects and discuss how to move forward the researches as follows.

1) Research subjects derived from reviews of legacy management methods related to IT systems

Subject1) *Systematization of IT specific PM knowledge*

As the IT applications spread to the social and economic activities more, the frequent occurrence of the IT problem projects may be a source of our larger threats. Thus, we first think it a basic subject that the IT specific project management knowledge for prime contractors depends on the tacit knowledge of individual PM and it is difficult to say that the knowledge is sufficiently generalized and systematized. Regarding the general project management, we also discuss about the following issue.

- Summarizing the tacit knowledge of PMs who are well experienced in field projects for developing IT systems.
- Identifying the IT specific knowledge that the PMBOK does not include and systematizing the total shape of the knowledge for PMs in the IT firm.
- Specifying tools for PMs to practice the management of actual projects based on the system.

We also evaluate the above method whether it can be a method to avoid problem projects with more certainty based on outcomes of applying the method to actual field IT projects.

Subject) *Derivation of a method to identify major risks*

Among problem projects in the IT firm, the SPPs, which have magnificent influences to the social and economic activities, occur due to multiple causes both inside projects and outside projects. Since early phenomena of the SPPs have shapes of complicated and long causal chains of multiple causes, it is often too late when countermeasures begin to be practiced at the time when they come to light. It is difficult to specify such phenomena that alert the risks of occurrences of the SPPs (major risks), even when we use the risk management in the PMBOK or the method for the general project management mentioned above. Thus, we derive a method to identify the major risks earlier in the IT firm, by proposing a cyclic causal model and using it for specifying SPP phenomena.

2) Research subjects derived from reviews of legacy management methods practiced by enterprise organizations

Subject) *Clarification of stakeholder responsibilities*

It has not been verified that legacy researches focusing only on PMs are not sufficient for preventing the occurrence of problem projects. This has been an obstacle to promote researches to prevent problem projects by stakeholders other than PMs. Therefore, we discuss about how the stakeholders including customers, senior managers and sales persons are related to the problem projects, by analyzing actual cases.

Furthermore, it is probable that the multiple phenomena due to the “multiple causes both inside projects and outside projects” mentioned in the former subject (*Derivation of a method to identify major risks*) include the multiple phenomena caused by the stakeholders. Thus, we discuss this subject first and the former subject next as shown in the following sequence.

Subject2) *Clarification of stakeholder responsibilities*

Subject3) *Derivation of a method to identify major risks*

Subject4) *Modeling manageable dependability*

Although we have increasing threat of IT accidents which may cause significant negative influences to the social and economic activities in the future, the management responsibility of the total dependability of the IT services in the user company is not clear. To cope with this, a manageable model to clarify the management responsibility of the total dependability of the IT services in the organization is proposed and evaluated from a viewpoint of improving dependability by using IT accident cases.

2.2.2 Features of the Thesis

Based on the discussions so far, the research subjects can be summarized in a matrix as shown in Figure 2-1 by considering a category of areas of the management knowledge (a horizontal axis) and a category of persons related to the project management (a vertical line). The thesis is positioned itself in a domain described as “domain covered by the thesis”, where the generalization or systematization of necessary knowledge required for PMs in prime contractors, stakeholders and IT owners are researched in the IT specific area.

There have been numbers of researches related to preventing the occurrence of problem projects as discussed before. However, as far as the following four problems are concerned, which is also described in the Figure 2-1, it is difficult to say that sufficient researches have been studied at present.

- Problems of less systematized PM knowledge for prime contractors despite spreading of the IT to the social and economic activities
- Frequent missing of the symptom of serious problem projects
- Unclear responsibility of problem projects
- Growing threat due to IT accidents

These problems are thought to be summarized as pending questions related to negative influences to the social and economic activities caused by problem projects in the IT firm. These questions have not been sufficiently researched so far. The first feature of the thesis is to practice researches by tackling with the pending questions of the IT related to the social and economic activities.

Classification of management method		Questions related to negative influences to the social & economic activities	Knowledge for IT area (reseach subjects in the thesis)	Common knowledge including non IT area
Management practiced by organization	by IT owner in user side	Threat due to IT accidents	**Subject4)** ***Modeling manageable dependability***	OPM3 Portoforio manangement Program management. P2M
	by stakeholders including senior managers of PM	Unclear responsibility of problem projects	**Subject2)** ***Clarification of stakeholder responsibilities***	
Management related to IT system	by PM in prime contractors	Missing symptom of serious problem projects Less systematized PM knowledge	**Subject3)** ***Derivation of a Method to identify major risks*** **Subject1)** ***Systematization of IT specific PM knowledge***	PMBOK
	by PM mainly in sub-contractors	-	CMMI	

(Note) [grey box]: domain of existing outcomes

[yellow box]: domain covered by the thesis

Figure 2- 1 Position and research subjects of the thesis

However, it is not easy to practice the researches. To cope with this, researches in the thesis are practiced by the following strategies. The idea of the two strategies is the second feature of the thesis.

1) Practical knowledge is generalized by using rich cases of actual problem projects.

It is difficult to conclude that legacy researches related to preventing the occurrence of problem projects have discussed based on sufficiently objective evidences due to lack of the cases. Consequently, they could not generalize their knowledge to apply widely to actual projects. The reason of this is thought to be that it is almost impossible for general persons to obtain the case data of problem projects which caused negative influences to the social and economic activities, due to restrictions of the individual corporate privacy. However, the author luckily has an opportunity to analyze rich case data of IT problem projects obtained from a working group (named the project *MIERUKA*), which consist of members from the IT industries, the IT related academia and the governmental organizations, in the Software Engineering Center of the Information-technology Promotion Agency, Japan (hereafter IPA) as a member or a chairman of the working group. This thesis analyzes the actual cases of the IT problem projects objectively and generalizes the obtained outcomes to shapes such as a method, tools or a model, so that they can be easily introduced to actual practices.

2) The thesis is based on the comprehensive research whose scope is not restricted to projects but covers wider range including enterprise organizations.

Although the PM has the major responsibility to execute projects, stakeholders such as senior managers or customers in IT user companies are called to account for negative events due to problem projects when they cause bad influences to the social and economic activities. Therefore, the standpoint of the thesis is not restricted to the project management practiced by PMs, such as the PMBOK dose, but the thesis expands the research scope to cover the management practiced by stakeholders in the enterprise organizations in order to obtain more effective outcomes for preventing the occurrences of problem projects. There has been observed less research trial which has such wider scope of the comprehensive research in the past. The reason is thought to be that persons, who have various experiences of the stakeholders and understand their jobs, are very limited. However, thanks to the IT firm, it is lucky that the author has been given experiences of not only PMs but also the various jobs of the various stakeholders in his life. Thus the author tries to practice the comprehensive research while he asks supports from members of the IPA working group.

2.2.3 Structure of the Thesis

The rest part of the thesis is organized as follows. As already stated at the end of the Chapter 1, suggestions of practical examples are also intentionally described in each chapter to move forward researches in this field of the project management.

Chapter 3 corresponds to the Subject1). Focusing on filed IT projects, we systematize the tacit knowledge of PMs who have never failed to achieve goals of the QCD in general IT projects. We also formalize the knowledge as tools for PMs in the general IT projects to easily introduce the method, and evaluate the method by applying them to actual IT projects.

Chapter 4 corresponds to the Subject2). Focusing on stakeholders other than PMs, we clarify how they have related to IT problem projects by analyzing cases of actual IT problem projects. As for clarified responsibilities of the stakeholders, practical examples of countermeasures for the stakeholders to achieve the responsibilities are suggested.

Chapter 5 corresponds to the Subject3). We focus on the SPP which may occur even if the method described in the Chapter 3 is introduced. We also propose a model to describe the growing process of major risks, which cause the SPPs, by using cyclic causal models. We next derive a method to identify earlier the major risks in the IT firm by analyzing the relationships between the model and the actual SPP cases.

Chapter 6 corresponds to the Subject4) and we focus on user companies who have the final responsibilities of IT accidents which have been increasing in recent few years. We extract two functional elements from a viewpoint of the management and systematize the total shape of the IT service dependability as a model. We also evaluate the model from a viewpoint of improving the dependability. Furthermore, we suggest practical examples of methods including tools to implement the model.

Chapter 7 summarizes and concludes the above results and present further researches for the future.

Chapter 3

Systematization of IT Specific Project Management Knowledge for Project Manager

3.1 Introduction to This Chapter

Developments with more vague and diversified specification are apt to be required from stakeholders with less IT knowledge to IT systems, which are being applied widely to social and economic infrastructures as mentioned in earlier chapter. In such high-context environments, it becomes difficult to be sure whether projects can achieve goals for QCD. In such sense, it is thought that status of projects becomes much less visible.

Since resources of PMs in prime contractors are limited, less experienced PMs may often be assigned to the difficult mission to achieve such project goals. It may become much more probable that problems of mismatch between the developed system and customers' requirement or too many defects come to light at the total test or running test just before the launch of IT systems, since status of such projects are difficult to visualize.

It may be probable that trouble-shooter PMs with enough experience often find facts such as no master schedule written or system configuration diagram not maintained, when they first check the problem projects. In such cases, they have to bear hardship of recovering.

With this background, it is thought to be a much more important issue to visualize IT projects whose status have been difficult to understand to prevent problem projects that are worries for the future.

Regarding the issue of IT, typical countermeasures such as SWEBOK [3-1] and in-process quantitative measurement [3-2] have been announced so far.

SWEBOK is a Software Engineering Body of Knowledge. Although various research papers have been reported regarding the software engineering so far, they are difficult to understand bird's-eye view of them systematically. To cope with the issue, the SWEBOK compiled an index to each significant paper by dividing them according to scientific categories. This is useful for persons in the academia to identify a position of each paper in number of researches in the software engineering. In this sense, the SWEBOK is thought to be a progressive result.

On the other hand, the in-process quantitative measurement is a new approach of research to measure actual status on-going projects within phases of in-process. Many of legacy researches to measure quantitative data have been made after projects are completed (in a phase of post process). On the contrary, the in-process quantitative measurement tries to understand status of projects earlier and more objectively by measuring in-process data. In this sense, this approach is also thought to be a progressive result.

However, they have at least one of following problems, which made them difficult to introduce to actual IT field projects. So that, it is thought that they could not provide countermeasures effectively enough to decrease occurrences of actual problem projects.

1) Individual solutions without systematizing the whole knowledge

PMs can judge risks only when they use not only quantitative methods but also qualitative methods such as project inspections in general IT projects. However, since what have been proposed are individual solutions such as the in-process quantitative measurement or are just a summary of them such as the SWEBOK, PMs cannot judge risks when they use only them. It is possible for PMs to use them in actual field projects, if they are shown how the individual solutions are related to each other and how to use whole of the solutions. Unfortunately, it is difficult to say that they can meet with such requirements.

2) Unclear way to be used when the PMBOK is already introduced.

Before the SWEBOK or the in-process quantitative measurement is used in actual IT projects, PMs who usually use the PMBOK may require clarifying the relationships between these solutions and the knowledge in the PMBOK, and they may ask what IT specific management knowledge these solutions provide. However, neither the SWEBOK nor the in-process quantitative measurement clarify the relationships and even discuss what the IT specific management knowledge should be.

3) Difficulty of immediately introduction to field IT projects.

If they are products in the research phase, they do not have tangible shape such as tools which can be used by practical managers and they have less practical results in general field IT projects. Even if they have some practical results in general IT projects, since most of them have restrictions of use and applicable phase, it is difficult to say that they can be used throughout the life cycle of general IT projects.

By the way, in the manufacturing industry, Toyota has begun to ship more cars than any other car company in the world. The success of production of Toyota is said to be due to field efforts practicing the *KAIZEN* [3-3], which the company has practiced to improve their products for more than 40 years. Toyota has also developed a visualization approach named *MIERUKA* as the basis for further *KAIZEN*. For example, although facts of important accidents are often disclosed in many companies, Toyota produced a system to immediately inform such facts including terminations of automobile production lines to management executives by *MIERUKA*. It has been pointed out [3-4] that Toyota systematizing *MIERUKA* has unified field sites and the company management, which has produced significant long-term improvements in QCD. Consequently, this has been strengthening Toyota’s ability to compete in the world market.

Thus, we developed such method naming the same *MIERUKA* for IT projects by applying the Toyota’s approach and have been promoting their introduction to field sites to visualize the status of Japanese IT projects in development.

The following topics are discussed about *MIERUKA* of IT projects (hereafter, simply *MIERUKA*).

- We clarify what management knowledge is necessary for PMs in prime contractors, by specifying marginal capacity of legacy standards including the PMBOK and the CMMI and showing total knowledge including IT specific knowledge.
- We clarify requirements for *MIERUKA*, based on the above results.
- We clarify a method of *MIERUKA*, which integrate the IT specific knowledge and the PMBOK and clarify the total shape of systematized knowledge for IT project management.
- We clarify tools for immediate introduction of *MIERUKA* to field projects.
- We evaluate impacts to field projects by introducing *MIERUKA*.

3.2. The Marginal Capacity of Legacy Standards

3.2.1 Marginal Capacity of the PMBOK

The PMBOK clarifies PM processes by defining 9 common management knowledge areas. The PMBOK has gained worldwide popularity by evolving PM's methods towards a more scientific style. However, the PMBOK does not totally cover IT-specific knowledge since it focuses on commonly held knowledge that applies to a broad spectrum of project management.

To be sure, the author tried to identify the IT specific management knowledge by analyzing some cases of projects which achieved not only planned QCD but also planned business performances at 2002. As a result, new knowledge including that related to customers, which the PMBOK does not have, has been pointed out to be necessary for IT project management [3-5]. However, this analysis could not show the total view of IT specific knowledge and systematize it. The reason is that the number of the cases is not enough for the systematization because the cases analyzed is based on the author's experiences.

However, the author had a chance to analyze more cases (the 193 cases) which had been collected from different companies and summarized by IPA at 2008 as mentioned at the Chapter 1. It is expected to be able to derive more clear view of IT specific knowledge system.

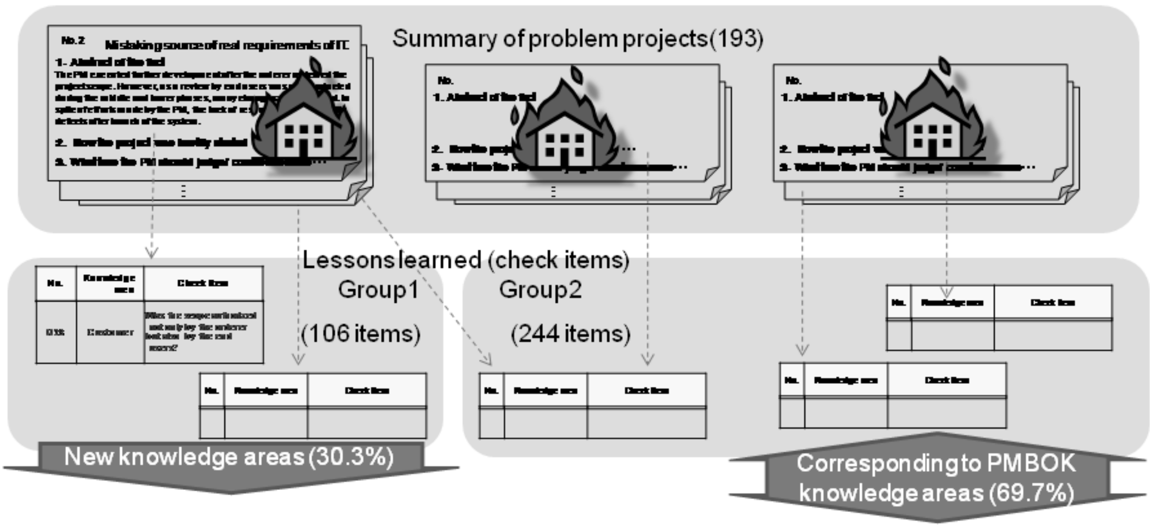
Actually, when necessary check items (350 items) are extracted not to reproduce the 193 cases of actual IT failure projects, by lessons learned from the actual cases and tried to assign them to the PMBOK knowledge areas, 106 items (30.3%) of all of the 350 items could not be assigned to the 9 knowledge areas. Table 3-1 shows the details of the analysis.

Furthermore, 6 new knowledge areas were found by classifying the 106 check items. Figure 3-1 summarizes what has been mentioned above.

Table 3- 1 Case analysis: Relationship between check items and the PMBOK

	Knowledge areas		The number of check items in Self check sheets			The number of check items in Hearing sheets			Total	
			Upper	Middle	Lower	Upper	Middle	Lower	Total	Rate
PMBOK	1	Integration	6	7	8	9	8	10		
	2	Scope	5	5	4	5	4	5		
	3	Time	4	6	5	10	6	8		
	4	Cost	2	1	2	3	2	2		
	5	Quality	2	3	1	4	5	14		
	6	Human resource	1	1	4	5	4	3		
	7	Communication	4	5	3	6	7	11		
	8	Risk	1	1	3	4	6	3		
	9	Procurement	2	1	1	3	5	4		
			27	30	31	49	47	60	244	69.7%
Not included in PMBOK	10	Customer	1	1	1	5	4	6		
	11	Technology	1	1	1	5	12	5		
	12	Organization	2	2	1	3	4	3		
	13	Basic action	2	2	2	4	4	3		
	14	Motivation	1	1	3	5	4	5		
	15	Task management	1	1	1	3	3	3		
			8	8	9	25	31	25	106	30.3%
Summary			35	38	40	74	78	85	350	100.0%

(Note) Upper (, Middle or Lower) means Upper(, Middle or Lower) development phase where the check items are investigated.



Customer	Knowledge about those stakeholders who have the right to decide the scope, budget and schedule. With this knowledge, the PM then has to collaborate, negotiate and make agreements with them, in order to complete successful system development.
Organization	Knowledge about the inside or outside of the organization in regard to the projects inside the PM's company, there are those in positions above the PM sales account who can affect the project. Outside the organization, there are sub contractors who act as business partners. The organizational structure can constrain "Human resources" or "Procurement."
Basic action	It is common practice in system development, to ensure that every software developer is accomplished. Knowledge of system development management is also included in this area.
Motivation	Knowledge about practices concerning the motivation of systems or software developing engineers.
Technology	Knowledge of system integration technologies or software development technologies in "Software engineering."
Task management	Management of issues in system development. Processes of best practice, which must be executed in field projects, are extracted from lessons learned recorded in the summary of problem projects.

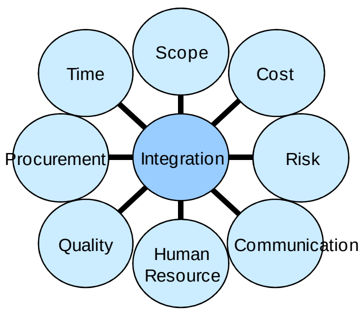


Figure 3- 1 IT-specific knowledge areas which the PMBOK does not cover

3.2.2 Marginal Capacity of the CMMI

The CMMI as applied to IT attempts to standardize engineering processes for software development. It also has gained a worldwide popularity by defining 5 levels to decide the maturity of processes executed in IT companies and introducing systems to certificate the level of the maturity. Effects of its introduction can be expected when requirements of buyers have less ambiguity and are decided in the detail of physical specification, and there is less major change or additional scope during the project execution. The CMMI can be expected to be effective lower-context environments**.** Since it corresponds to the environment of projects that design programs, make code, and test software, the main Japanese application areas of the CMMI are thought to be lower level contractors in Japanese organizational structure of multi-layer subcontractors. However, there are many cases when buyers hardly have any power to decide their order specifications from the beginning even if times go over the dead line. Moreover, even after the specifications have already decided upon, requests for additional scope or change scope may continue.

In projects which accept such requests of buyers, the occurrence of risks of defective quality, delays of launch dates, or cost overruns becomes higher particularly in the lower development phases. When such risks occur and the failed projects are investigated, there often observed problems such as the absence of written master schedules or the lack of system configuration diagrams. In such field projects, the required scope, progress, and quality of products in development are becoming more invisible due to recent changes such as an increased number of stakeholders and shortened development periods. Since buyers with less IT experience and prime vendors with less knowledge of business and culture of new application areas increase due to radical expansion of applying IT as stated in earlier stage, projects with higher context environment also increase. This results in the increase of invisible projects not only in Japan, but also the world.

These problems are not caused by an engineering process, but rather by management, which should be executed in an environment of higher context, where projects are invisible.

Major areas covered by engineering processes as described in the CMMI are shown in the zone A in Figure 3-2. On the contrary, methods of the management mentioned above (shown in the zone B in the same figure) have not been proposed. Thus, if such management methods are not developed, future projects will be subject to failures.

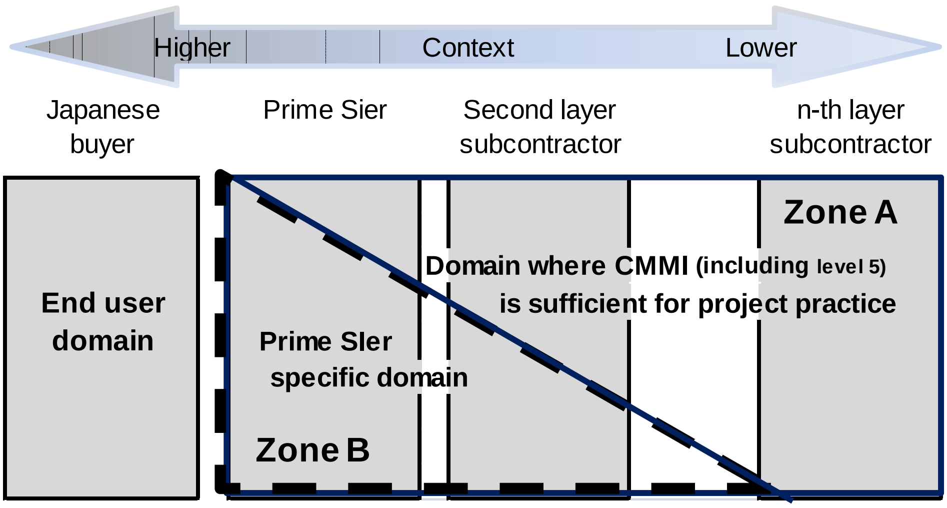


Figure 3- 2 Applicable zones of the CMMI and specific zones of Prime SIer

3.3 Requirements of the *MIERUKA*

The amount of development should be increased because of the increasing demand for IT.

When we increase developments only with legacy standards, it is much more probable that many failure projects occur due to the following causes in the future even when we use offshore resources with enough knowledge of PMBOK and CMMI.

- Fewer PMs with experience in higher context environments.
- Less IT-specific management knowledge that is extracted from the failure of projects.

Thus we designed the *MIERUKA* to resolve such problems by resolving the following issue mentioned earlier and try to give it shape in the next section.

1) Issue of “individual solutions without systematizing the whole knowledge”

It is required for the proposing method to let PMs be able to judge project risks by showing how the individual solutions in the proposed method are related to each other and how to use whole of the solutions.

2) Issue of “unclear way to be used when the PMBOK is already introduced”

It is also required for the method to make it possible to use the method together with the PMBOK, by making it clear what new knowledge is IT specific knowledge as shown in Figure 3-1 and clarifying the relationships between the solutions in the method and the knowledge in the PMBOK.

3) Issue of “difficulty of immediately introduction to field IT projects”

It is also required for the method to provide tools which do not have any restriction of use and applicable phase and can be applicable throughout the life cycle of general IT projects.

3.4 Method of the *MIERUKA*

Roles of the zone marked B corresponding to the higher context environment in IT development shown in Figure 3-2 have been fulfilled by tacit knowledge of PMs in upper level contractors (the top of them are prime SIers). We systematized the knowledge of PMs that have been successful in achieving QCD in high-context Japanese environments and summarized it into a method by asking supports from veteran PMs from major 20 prime SIers in Japan.

We systematized the method by decomposing the method into following three parts as illustrated in Figure 3-3, to make one to understand the tacit knowledge of the project veterans easier.

(1) The qualitative approach of *MIERUKA*

To understand the essential problems of a project from various points of view, we focused on the three viewpoints listed below:

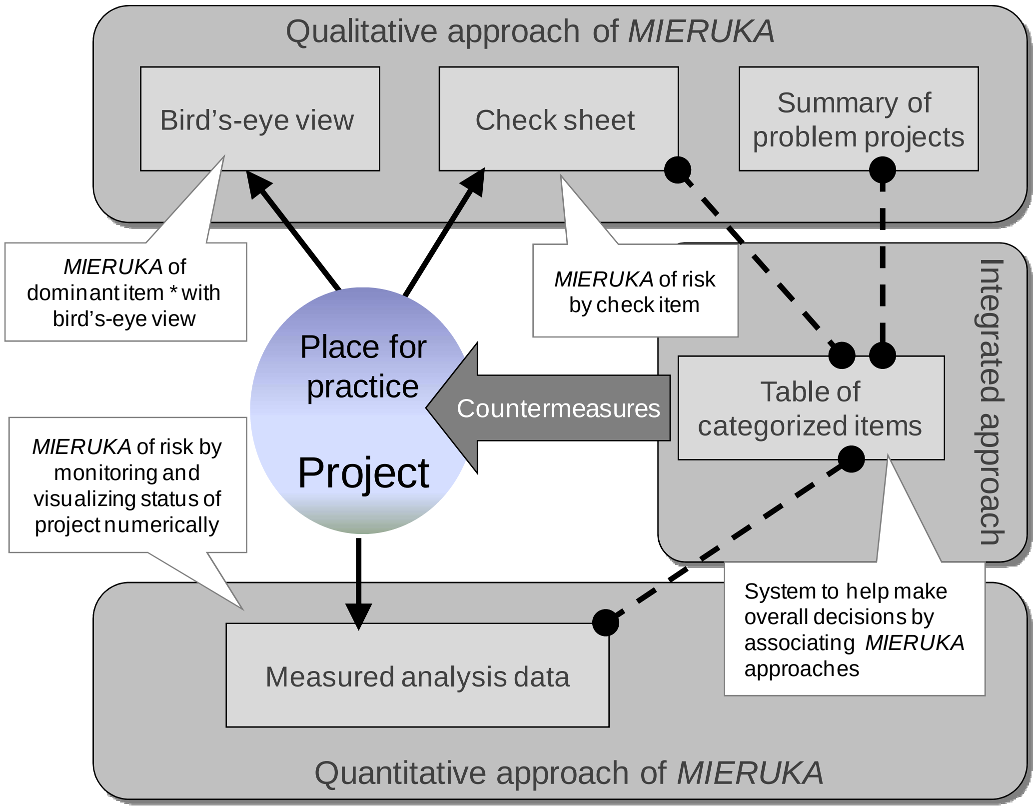
- Bird's-eye view for understanding the macro vision of the entire project, which is difficult to understand if one stays only inside the field of a project.
- Check sheet to point out hidden risks comprehensively by systematized way considering the IT specific knowledge areas and by visualizing the results of the inspection also to the third party.
- Summary of previous problem projects, which contains a record of the facts and lessons learned from actual projects that happened in the past.

(2) The quantitative approach of *MIERUKA*

Some risks are difficult to concretely understand when only the qualitative approach is used. To identify such risks and objectively judge specific countermeasures, we made a list of measured analysis data, which visualizes the status of a project numerically in IT-specific knowledge areas.

(3)The integrated approach

To systematically bring all risks in the higher context environment to light and to make easier decision making, we summarized and categorized views for verification into several items, with which veterans point out problems for actual projects. We also created a table of the categorized items that integrates both the qualitative approach and the quantitative approach by associating each of them to the check sheet, measured analysis data, and the summary of past problem projects.



*: Dominant item : The factor that is most strongly related to the success or failure of a project

Figure 3- 3 Systematization of *MIERUKA* method

3.5 Implementing Tools for the *MIERUKA*

3.5.1 Developing Tools

For our *MIERUKA* method, we do not stay proposing, but we give shape to tools, which can be immediately introduced to general field projects, due to the following features of *MIERUKA*.

(1) Being practical

Members of the *MIERUKA* committee, who have 20 to 40 years of experience in IT projects of major Japanese SI vendors or IT makers, designed and developed *MIERUKA* tools. Moreover, the tools were released after verifying them in practical usage of general field projects.

(2) Supporting *MIERUKA* for whole phases of development

Risks and problems of projects vary, depending on phases of project as follows, in the viewpoint of *MIERUKA* or action process after execution of *MIERUKA*. Therefore we developed tools to meet requirements from each phase of development.

Upper phase: Risk symptom in executing system development is necessary to share with project stakeholders at requirement definition or basic design.

Middle phase: Defending and eliminating potential failure is an important issue in software design, programming, and software testing. In this sense, it is necessary to effectively execute *MIERUKA* for scope verification of products from the upper phase, or *MIERUKA* for quality and progress of products made by the contractor.

Lower phase: Hidden problems of quality and progress often come to light suddenly during integration testing and final test. As time and means are limited, we need a series of three activities to cope with the problem: execute quick *MIERUKA* of the problem, specifically define the problem (we call this action *IERUKA*), and recover the system (we call it *NAOSERUKA*).

Next we would like to explain each tool. First as a Bird's-eye view in the qualitative *MIERUKA* approach, we gave shape to several sample figures to understand "dominant item," which decides if the total project may fail or succeed, from various points of view (stakeholder, system configuration and others).

We developed two kinds of check sheets: a self check sheet for the PM, and a hearing sheet for the inspection specialist, such as the PMO (Project Management Office). The summary of problem projects is made of 193 lessons learned from previous IT projects.

In addition to the qualitative approach, we created 232 items of measured analysis data for the *MIERUKA* qualitative approach in order to judge the concrete status of the project numerically.

Finally, in an integrated approach, we designed *MIERUKA* for the whole status of the project, like the cockpit drill, by associating each of the categorized items to the check sheet, the list of measured analysis data, and the summary of previous problem projects.

A summary of *MIERUKA* tools is shown in Table 3-2.

Detailed information can be obtained from references [1-24] [1-25] [1-26].

Table 3- 2 Summary of *MIERUKA* Tools

Approach	Tools		Contents	Volume of tools		
				Upper	Middle	Lower
Qualitative	Bird's-eye view		Used to assess the "dominant item," which may then influence whether a total project may fail or succeed, yet can not be detected from within the project. Sample figures for several viewpoints (stakeholders, system configuration, resource transition and so on) are available.	6 pictures	7 pictures	4 pictures
	Check Sheet		Used for detecting risks or problems.			
		Self check sheet	Check sheet for project manager (PM), which he/she uses to check the status of the project.	35items	38items	40items
		Hearing sheet	Check sheets used by inspection specialists who work on outside projects, which he/she uses to check the status of the project, while interviewing the PM.	74items	78items	85items
	Summary of problem projects		Records the facts and lessons learned about actual problem projects.Used to identify countermeasures toward similar risks or problems of the past, so as to avoid reproducing the same problems.	58 events	58 events	77 events
Quantitative	Lists of measured analysis data		Summary of indicators used to measure the concrete status of the project numerically.	78items	84items	70items
Integrated	Table of categorized item		List of categorized items, which are used to verify risks and problems. This table can be used like a cockpit drill because the list associates to check sheet, measured analysis data and summary of problem projects.	1 table	1 table	1 table

3.5.2 Bird's-eye View

In a project of developing systems, some dominant items, which are related to the success or failure of the project, must exist. It is quite difficult to predict what will be the causes and effects in developing systems because each of the projects has its own characteristics. Due to this kind of difficulty, we have to think carefully about "What is going to be the dominant items?" when we draw out the Bird's-eye view. As a result, the points that we actually need to concentrate on will be clear, and we can make Bird's-eye view which is convincible to us and to partners.

Figure 3-4 shows an example that the C Project members, who receive an order, are asked by the Hospital WG members, who order the request, to construct a hospital system in a very short term. If you arrange a Bird's-eye view of stakeholders, you can see that it is risky to conclude that the request depends on just WG members. In Figure 3-4 twenty related departments are in concern, so the way of request is unclear. Also, the Bird's-eye view enables you to see clearly who finally decides the way of request. When you come to see these things, there are two plans you can take.

PM: propose to the meeting of deciding the way of request that includes the project owner and the concerned departments.

Superiors of the PM: If the request is not acceptable, they will negotiate directly, and make the request acceptable.

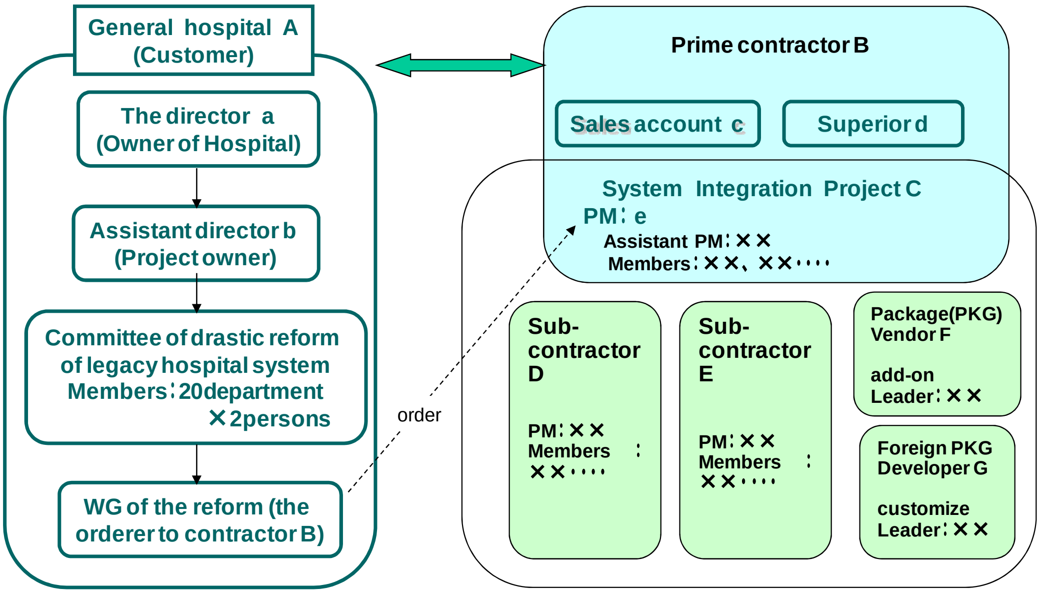


Figure 3- 4 Bird's-eye view of stakeholders (example)

The example above explains the structural problem of the side of ordering the request – the situation that the project owner does not take part in the project. Similarly, in the other Bird's-eye view in Figure 3-5, the following effect can be expected if customers and SI vendors cooperate and make arrangements together.

- We will be able to control the dominant items from diversified and systematic views.
- Structural countermeasure towards dominant items can be likely taken by superiors of the PM and so on.

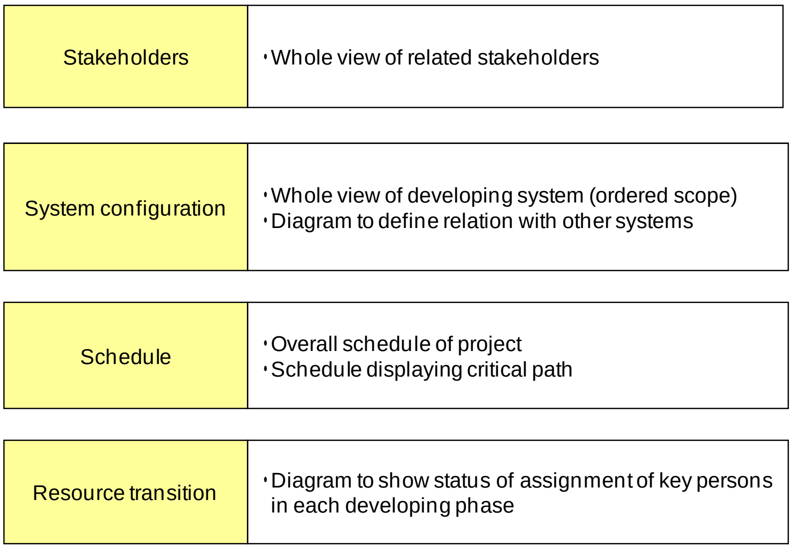


Figure 3- 5 Templates of Bird's-eye view

3.5.3 Check Sheet

There has been no systematic category other than the 9 PMBOK knowledge areas in legacy checklists in the IT firm. Thus PMs have difficulties to practice IT specific inspections in their project. On the contrary, the Check sheet in the *MIERUKA* is contrived to consider not only 9 PMBOK knowledge areas but also a field of developing software's own knowledge system. 6 new fields of knowledge are added from lessons from failed projects and the software engineering; "Customer," "Organization," "Basic Action," "Motivation," "Task Management," and "Technology" (Figure 3-1). The Check sheet involves check items, each of which is classified to the total 15 knowledge areas (Examples of check items are shown in Table 3-3). Thus the Check sheet is not only useful for IT projects which have not introduced the PMBOK but also easy to expand legacy checklists in IT projects which have already introduced the PMBOK.

Consequently, it becomes to be able to display results of project inspection by the check items in a way that the results are summarized to each of 15 knowledge areas (See ladder charts in Figure 3-6). The PM can notice the problems and risks, which were inconceivable to him/her for the project by utilizing the Self check sheet (See left side ladder chart in Figure 3-6). However, by using Hearing sheet, the PM can notice more details about the problems and risks that do not depend on his/her subject because experts evaluate the problems and risks form the outsider's view (See right side ladder chart in Figure 3-6). Especially, in a situation of lacking enough PMs, superiors' concerns would focus on visualizing of PM's performance when they reluctantly have to entrust a new project manager with a project.

No.	Knowledge Area	Check Item	Individual Interview Instructions	Assessment Criteria	Evidence / Checking Method	Measures
H33	Scope	Is there any unexpected expansion of scope (scope of functionality and work)? If yes, is the expansion within the acceptable range?	1) Countermeasures (reduction of functions, increase of cost, and change of scope) in response to scope expansion shall have been agreed in advance with the customer. 2) If the scope increases, determine the level of impact due to increase in tests or on critical functions.	The expansion of the scope must be kept track quantitatively. The expansion shall be assessed from the perspective of cost and schedule whether it is within the acceptable range.	(1) Change management table (2) Minutes of meetings	If the expansion is beyond the acceptable range, clarify the scale of the expansion and then hold a discussion with the customer. This does not include cases where the significant changes in the scope of functions and tasks are made under the consent of stakeholders, and the increases in cost and delay in delivery due to these changes have been agreed by the customer.
H54	Technology	Has architecture design been performed as a basic activity to implement the system?	The objective of architecture design must be understood. In architecture design, persons who have actual experience must perform design, or they must participate in the project as reviewer.	Architecture requirements and architecture design must be reviewed. - Hardware: non-functional requirements must be reflected in the infrastructure (facilities). - Applications: requirements such as protocols in external connection or common log output must be reflected in the common design. - User interface: error messages and function keys must be defined as unified specifications.	(1) Review documents	Allocate the timing to perform architecture design in the total plan.
H66	Organization	When using partner companies, aren't the ordered parties becoming multileveled, and aren't scope of responsibilities becoming ambiguous? Aren't there problems as a result of this multilevel relationship (such as scope of responsibility and communication)?	In a multilevel relationship, who is responsible often becomes ambiguous. It is important to build an organization after evaluating which structure is better: multilevel or flat.	Role assignment and responsibilities must be clear.	(1) Organization chart (2) Role assignment table (3) Interviews	Establish a meeting structure and gather key personnel from each company. At the meeting structure, confirm and review the scope of responsibilities of each company and have regular communication.
H70	Customer	If business restructuring is included, has feasibility been discussed considered during planning?	Feasibility of the details of business restructuring shall have been verified and a consensus shall have been reached with the customer. - Has feasibility been verified by a walkthrough with business and technology experts? - Are there records which show that the terms and conditions have been checked and contain no oversights? - It must be verified that there are no oversights in performance (such as the amount of time required for batch processing or online response time) and technical inconsistencies.	Verify that the positioning and expected role of the system in business restructuring is clear. Verify that disproportionate emphasis is not placed on idealism and that there is conformity to actual logic.	(1) Project plan document (2) Risk management table	If not considered yet, consider the feasibility of business restructuring and manage it as a risk if there may be a problem. - Since field-level adjustments may be required, share understanding with the customer.

Table 3- 3 Examples of items in Check sheet

Compared to this, tools on this paper can show the relations between the two persons like lower side graph in Figure 3-6, and information for when the superior who entrusts sees the situation of project risk and intervenes in the project is also visualized.

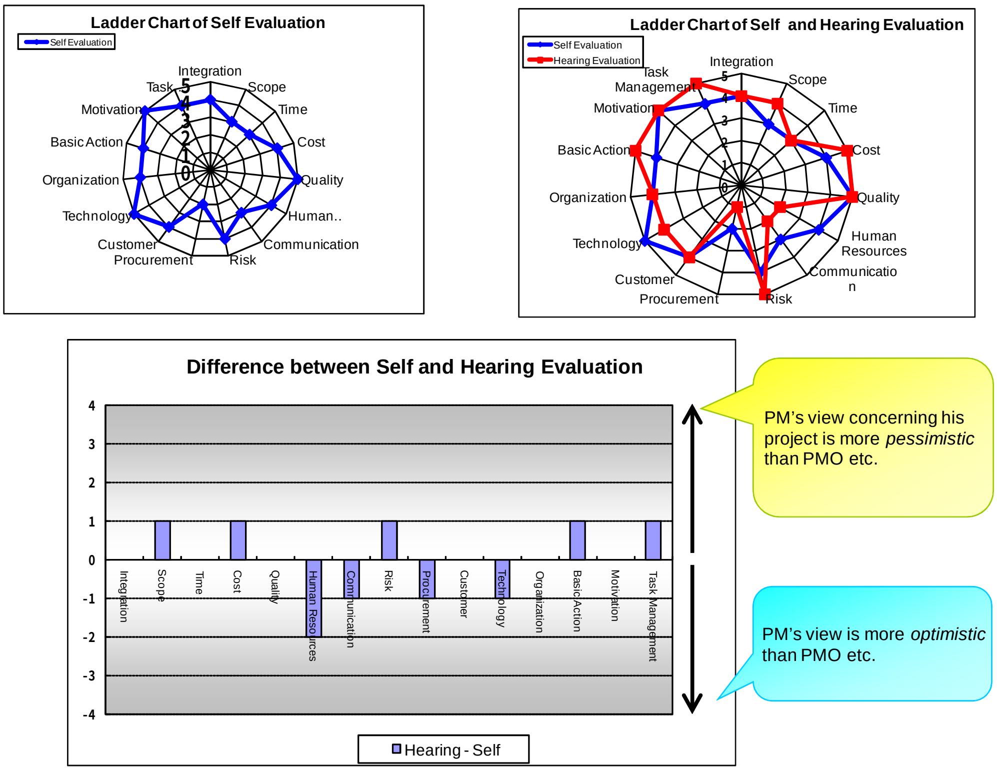


Figure 3- 6 Example of display using Check sheet

3.5.4 Quantitative *MIERUKA* Tool

It is necessary not only to watch if scheduled tasks on a progressing project are actually executed or not, but also to objectively understand the project's actual progress as data.

For example, Figure 3-7 shows an example of understanding incompleteness of quality by measuring Soft MTTR (Mean Time To Repair calculated by average transition of 5 days) as Measured analysis data in the testing phase. In this case, when value of MTTR exceeds that of MLM in Figure 3-7, which is empirically set beforehand, concentrated quick actions were made to recover the defected programs. Thereafter MTTR went down and quality defect, delay and cost overrun could be avoided in the project. Items of such Measured analysis data were systematically extracted from a point of view of 16 knowledge areas shown in Figure 3-1. As shown in Table 3-2, the results were 70 to 84 items listed for each developing phase.

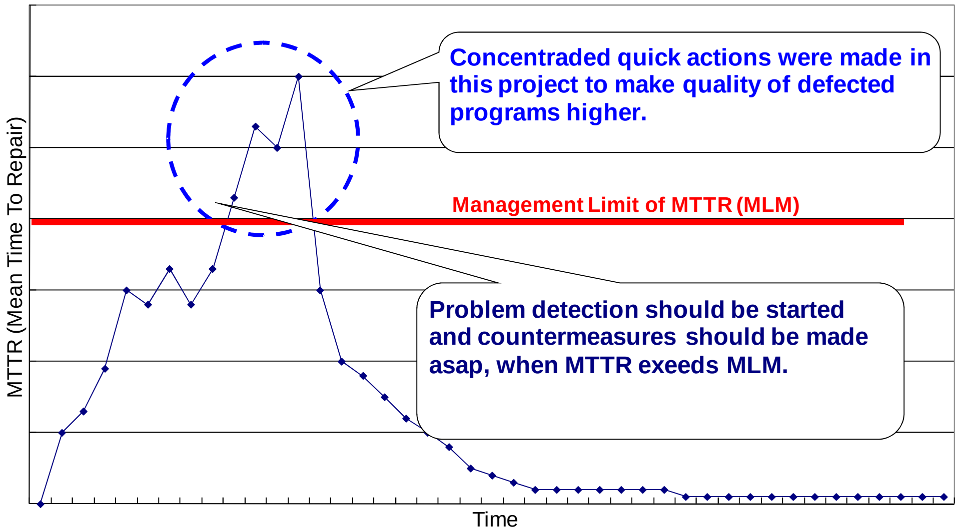


Figure 3- 7 Example of Measured analysis data (Soft MTTR)

3.5.5 Summary of Problem Projects

Failing makes project managers understand how to avoid making the same mistakes. The experienced sectional meeting committee of Project *MIERUKA* developed a database based on what they learned from experience about failed projects that had actually happened in the past. An example of the database is shown in Figure 3-8.

By using the examples, a project manager could experience the following visualizing effects.

1) Visualizing the decision of invisible project situation – mainly for project managers with minimal experience.

If project managers with minimal experience refer to these examples and discover the clues to success when they predict or face the problems, the expectation is the increased possibility of project success.

2) Warning against inaccurate prediction – mainly for project managers with some experience.

Project managers with some experience who have fortunately never failed at a project tend to carelessly consider risks due to their having too much confidence. If they know about the other Summary of problem projects, the expectation is that they would take their own project more seriously.

Case number

1 Urgent Request for Scope Change

After the scope of an online nationwide core enterprise system had been agreed upon by a customer, the customer required a major scope change, The customer explained that the scope change was necessary to compete with the new service provided by the rival company, and implicitly told the PM that there would be no assurance of continuous orders if the requirement was not accepted. The PM discussed this issue with a senior manager. However, the senior manager said that there were no extra resources but that they must fulfill the requirement, because there seemed to be no way of keeping the business except by getting continuous orders from the customer. The PM tackled the problem alone, but serious troubles occurred including frequent system shutdowns after cutting off the system.

Why was the project hastily started?

The PM judged that it is most important to make a quick response to the customer's strong request. Also the PM underestimated the impact of the requested urgent change to the project.

What should the judgement have been?

The PM should have thought that that although there were no extra resources, they must not be understood and shared, unless the same precision of estimating the initial baselines of the project was kept even when the scope change occurred.

Examples of countermeasures

SI vendor side

1) The PM should negotiate with the customer regarding ways to reduce the project workload, including the postponement of the existing delivery plan of some functions or a proposal of the step-by-step release of the additionally requested functions.
2) If the project is still risky, the senior manager of the PM should explain the risk to the customer or the senior manager of the customer and negotiate with them himself/herself.

Customer side

If the customer decides to carry out the scope change even after the risk is explained, a contingency plan should be prepared including a quick system recovery scheme.

Figure 3- 8 Example of a case in Summary of problem projects

3.5.6 Integrated *MIERUKA* Tool

Even project managers who have significant experience tend to miss checking risks and make careless mistakes if they use only the Check sheet. Compared to this, if the PM checks not only the Check sheet but also the Summary of problem projects and the Lists of measured analysis data, the PM can manage a project with sufficient information quite well as if using the cockpit controls to fly an airplane.

Figure 3-9 is an example of the Integrated *MIERUKA* tool for the upper developing phase, where the Summary of problem projects and the Check sheet are compounded. The expectation is to have an effect on preventing expert project managers from failure, even if they are confident that failure is unlikely.

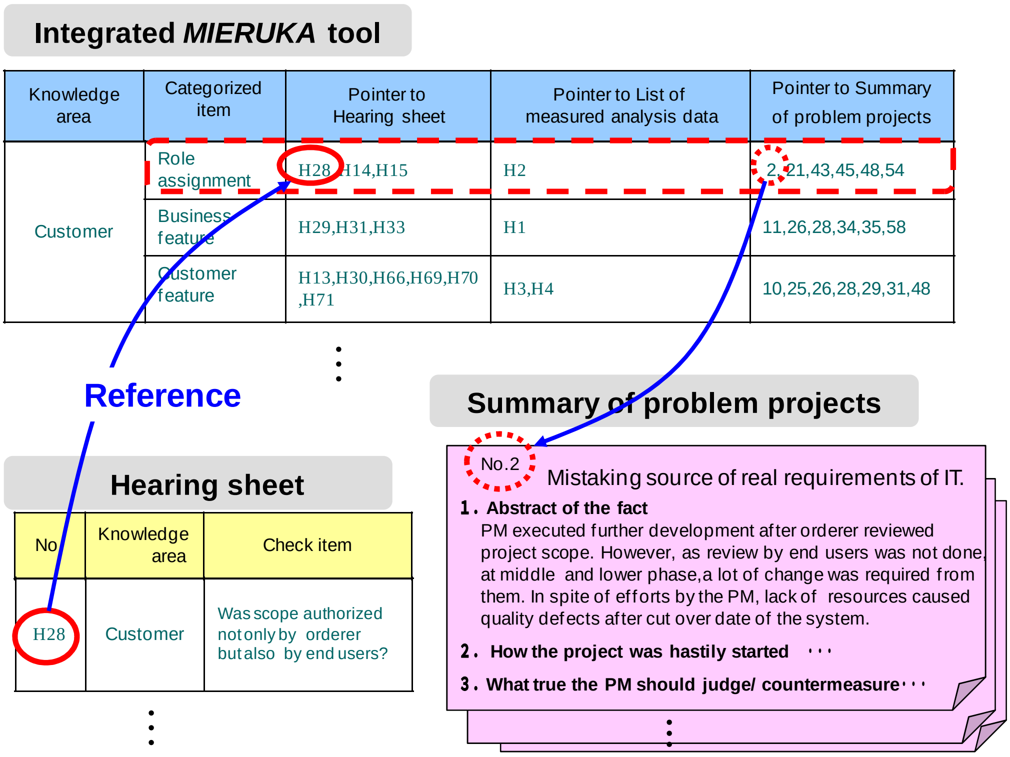


Figure 3- 9 Integrated *MIERUKA* tool (1)

Figure 3-10 is another example for the lower developing phase, where the Check sheet and the Measured analysis data are compounded. There have been problems, which cannot be detected only by checking qualitatively if scheduled tests are actually executed (example: the problem of incompleteness of quality as mentioned in former section). It is expected to make shooting such problems (executing *IERUKA* and *NAOSERUKA*) faster than before by visualizing the problems quantitatively.

As explained above, the Integrated *MIERUKA* tool makes it possible for PMs to check risks from multi and total points of view, including qualitative and quantitative aspects by integrating the Check sheet, the Measured analysis and the Summary of problem projects.

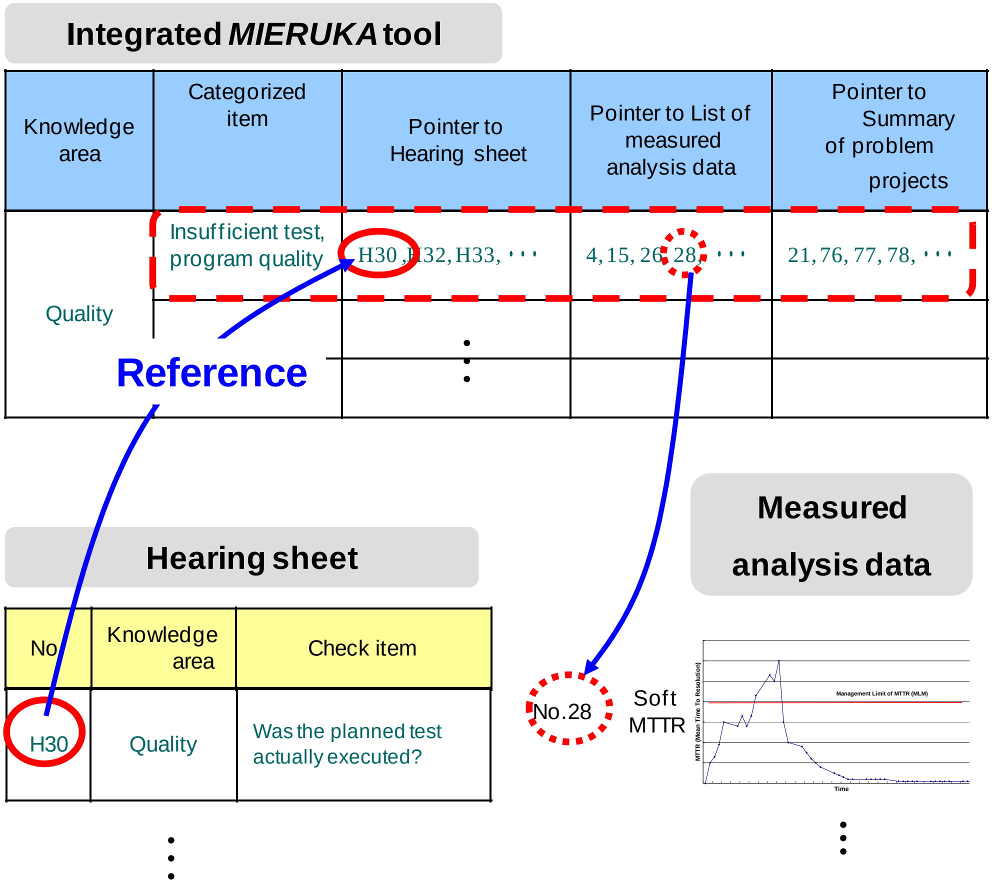


Figure 3- 10 Integrated *MIERUKA* tool (2)

3.6 Effects of Implementing the *MIERUKA* to Field Projects

3.6.1 Application of the *MIERUKA* to Actual Field Projects

The *MIERUKA* tools in this thesis were applied to approximately 50 information service companies.

Comparing before the tools were applied with after the *MIERUKA* tools were used, the loss by executed unsuccessful projects was reduced by 20% to 30%. However, total sales did not change either before or after the tools were applied. The judging time per project for the Check sheet was in the conceivable range, which was approximately 30 minutes for the Self check sheet and approximately 2 hours for the Hearing sheet. From these results, we confirmed the practicability of the tools.

3.6.2 Consideration

From the results of sectional meeting activities over a long period of time, the *MIERUKA* method was developed. *MIERUKA* has the following characteristics:

- The *MIERUKA* method was systematized as mentioned earlier.
- Although a sea of methods that treat part of a project exist, the *MIERUKA* method covers all project processes from the beginning to the end.
- Not just proposing the method, but offering tools that underwent actual application and can be used immediately.

For the above, it would be expected that the method helps us find problems in the project and immediately solve them, and it raises the possibility of project success. The results of applying former section indicate the considered result that would suit the expectations.

3.7 Conclusion

The issue we presented at an earlier stage was that the status of general field IT projects are difficult to be visualized by legacy methods, which may cause outbreaks of problem projects in the future.

To cope with this issue, a method with the following features was proposed to cope with problems in field project management practices which neither the PMBOK, nor the CMMI and other IT specific solutions are able to resolve:

- A systematized method of *MIERUKA* for managing field projects in higher context environments.
- Tangible tools of *MIERUKA*, which cover IT-specific knowledge including that of PMBOK, for immediate introduction to all upper to lower developing phases of field projects.

We also confirmed that *MIERUKA* tools could be introduced to actual field projects and problem projects were reduced after introducing the tools.

Values of the results discussed so far increase more if one does not stay announcing them in the academic societies and proceed to introducing widely to the actual IT firm. For such objectives, the author has not only published several books [3-6] [3-7] [3-8] [3-9] [3-10], but also has lectured at almost all of the major Japanese cities (Fukuoka, Osaka, Tokyo, Sendai, Sapporo and so on) [3-11] as a chairman of sectional meeting of project *MIERUKA* of IPA/SEC in Japan.

Moreover, it is required to spread the *MIERUKA* also in foreign countries, since amounts of IT offshore developments are increasing. So far, the author has made presentations of papers regarding the *MIERUKA* at several countries [3-12] [3-13] [3-14] [3-15] including China and Thailand. Some IT companies in Asia Pacific countries begin to ask me to support introducing the *MIERUKA* to their companies. The author has future plan to continue such activities for popularizing the *MIERUKA*.

The *MIERUKA* is a method that can be applied to general IT projects for improving their success rate. Thus it is thought to raising bottom level of IT developing firm higher.

However, this method does not resolve all of the issue of problem projects, since it is mainly applicable to PMs. The *MIERUKA* is not sufficient method for preventing problem projects, when problems are caused by complicated causal chains influenced by stakeholders other than PMs and by project environment.

We verify and discuss the research issue in the next 2 chapters.

Chapter 4

Clarification of Stakeholder Responsibilities

4.1 Introduction to This Chapter

We define a serious problem project (SPP), which has significant influences on social and economic activities, as one that satisfies one of the following three conditions and we clarify the causes of SPPs in this thesis,
1) Significant quality problem broadcasted by the news.
2) Delay of service start planned by the customer.
3) Cost overrun exceeding one hundred million yen.
The popular PMBOK describes processes for a PM to prevent SPPs with more certainty.

However, before a SI project is initiated, the PM’s customer, senior manager and salesperson (hereafter called planning stakeholders or simply PSs) agree on a project charter (more commonly, a contract that defines the project objectives or requirements), which has a significant influence on the later project’s success or failure. However, the PMBOK recognizes project charters as products of the pre-project phase, where a PM has not yet been assigned. Thus, it should be noted that the PMBOK does not explain the specific process of how the PSs should execute negotiation procedures in order to create a project charter that will prevent SPPs, There is another standard such as the OPM3,for organizations including a PM’s senior managers. Some SI companies may also define specific and detailed processes for senior managers or salespersons to improve the efficiency of business administration or order acquiring. However, there is no report where those process standards are defined primarily for the PSs to prevent SPPs, in a practical form like the PMBOK.

Although examples of verification of actual project cases are limited, followings are the major reports.

Furuyama et al. [4-1] analyzed factors of project success or failure by rich actual project data, and verified various hypotheses, which have been proposed empirically. However, although the data used in the analysis include projects with minor problems, data of SPPs are omitted, because a book which provided the data source [4-2] says that the difference between the data and the mean value exceeds the limit and they are treated as not ordinary cases. Moreover, their analysis view point is focusing mainly on PM process such as specification determination and cost estimation, analysis focusing on PSs is not conducted.

Smith [4-3] [4-4] proposed that there are 40 root causes regarding troubled IT projects, referring many problem projects. He also attempted to clarify boarder line of responsibility between the customer and the SI company. However, it is not discussed about breaking down of responsibility for problem projects (ex. who is responsible of PM or the senior manager), when SI company is responsible. Additionally, since he did not disclose his analysis method, his analysis quantitative results and some troubled project cases of his own experience, another conclusion other than him can be found, if some other person does the same thing as him. That is, there is no assurance of reproducing his analysis and proposal. Moreover, the range that he recognizes troubled IT projects includes cases when buyer did not commit success or cases when relations between vendor and buyer became worse. Thus, as results of extracting cases depend on subjective judgment of case extractor, it is thought that his cases of troubled project are not necessary equal to the SPP cases.

White [4-5] analyzed a failure case (London ambulance IT service system), which is thought to be SPP case, and studied on failure factor influencing from outside project. However, as the numbers of cases are limited, there is no discussion about total trends of SPPs.

Other than above, there are some results of case analysis, including Yeo [4-6] and Sutterfield et al. [4-7].

However, they have at least either one of the following problems.

- It is difficult to say that they have identified SPP cases with a clear definition from viewpoint of social and economic influence and they have collected the sufficient number of SPP cases to discuss about total trends of SPPs.

- They did not clarify who is responsible of SPP cases among the PSs.
- There is no mean to make assure that the validity of their proposal or their results of the analysis, since they did not disclose their process or method of case specification and case analysis.

It is supposed that the reason why they could disclose less information is that constraints of personal or corporation privacy, regarding responsibility of SPPs, became barrier to open case analysis.

Thus, it is difficult to say that the relationship between a PS and SPPs has been discussed by using objective evidences and consequently the relationship has been vague to date.

This is thought to limit project management standards by focusing mainly on the PM and creates a barrier against moving toward standardization of project management by PSs. This also is thought to be one of the reasons not to promote defining their roles, responsibilities, and processes. Moreover, this unclear status is thought to cause SPPs.

Therefore, we will discuss a case analysis in this thesis, which satisfies the following three conditions:

1) To establish a clear definition of SPP cases from the viewpoint of social and economic influences, which enables objective specification of them, and to collect and analyze them.
2) To clarify individual responsibility among PSs through the analysis.
3) To prevent intentional operations of the results by disclosing the processes used for collecting and analyzing cases.

4.2 Viewpoint of Analysis

4.2.1 Responsibility of PSs

After an information system project is initiated, there are many stakeholders (as shown in Figure 4-1) and a PM becomes the person in charge of project management. However, before the project was initiated, a salesperson, who is responsible for acquiring orders, executed independent action to propose ordering the SI item for the customer, who in turn is responsible for project objectives and requirements, and will also be a counterpart in project negotiations with the PM in the future. After the sales negotiation, when acquiring the order and a project charter draft is nearly agreed upon with the customer, a senior manager verifies the project charter, assigns the PM, and formally approves acquiring the SI order.

In this thesis, we define the PSs (the customer, the senior manager and the salesperson), who are participants in deciding the project charter, and the PM as major stakeholders and focus on who should be responsible for SPPs among the four major stakeholders.

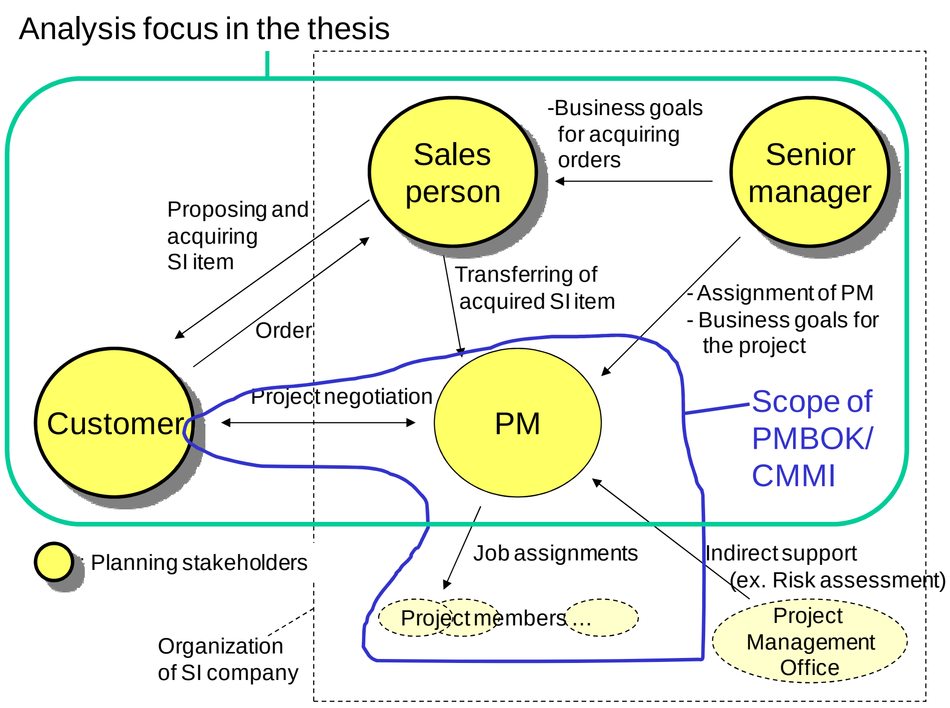


Figure 4- 1 Basic relation among stakeholders in SI company

4.2.2 Misunderstanding the Differences of Value and Culture

Many persons including DeMarco have discussed and pointed out a risk source in the so-called multicultural environment, including the differences of value and culture between the customer and the PM [4-8] [4-9]. However, the relationship between the risk source and the actual harm and the quantitative magnitude of the actual harm has not been discussed based on objective evidences.

Although, there previously had been no clear definition of misunderstanding the differences of value and culture, the Information-Technology Promotion Agency, Japan (IPA) defined it in its recent report [3-6] as the status where both the buyer side and vendor side do not share project risks or business values.

Thus, we also analyze the relationship between SPPs and misunderstanding the differences of value and culture using this definition.

4.3 Case Analysis

4.3.1 Method for Case Specification

To avoid problems caused by constraints of personal or corporation privacy which were mentioned before, we obtained information regarding troubled projects from a sectional meeting named Project *MIERUKA* held at the IPA,where strict privacy standards are maintained. The meeting members were primarily veterans of project management of large-scale systems developed by major Japanese SI and IT makers or key persons of the Project Management Office, who have led the recovery of many troubled projects.

Cases of troubled projects were recorded by the members as a series of facts including how the projects became troubled, what countermeasures the PMs took, and the outcome of the projects. One hundred ninety three cases were summarized and disclosed [1-24] [1-25] [1-26].

However, since the 193 cases included cases with minor problems, we extracted SPPs from cases with a major impact as previously defined. The members who described the cases specified the SPPs and all of the results were accepted by the sectional meeting. Through this process, 107 SPPs were specified by summarizing all cases as problems occurring in the upper, middle and lower phases.

4.3.2 Method for Case Analysis

We investigated the relationships between the 193 cases and responsibilities of PSs as well as misunderstanding the differences of value and culture.

As information regarding such relationships is not included in the summary of troubled projects, we asked the members who provided the cases to investigate these relationships. Particularly, in order to avoid disagreements regarding misunderstanding the differences of value and culture among the individuals, the definition of it was explained beforehand to every member and the investigation was conducted using the following definition of responsibility assignment.

1) Responsibilities of customers and SI companies

Customers are responsible for budgets and requirements (including incomplete specifications and any delay of specification decisions). The SI companies are required to take charge of realizing the required system.

2) Responsibilities of senior managers, salespersons and PMs in the SI companies

Following are criteria for determining their responsibilities.

- PMs are responsible when they neglect basic actions described in the PMBOK or neglect reporting risks to their senior managers after the PMs first

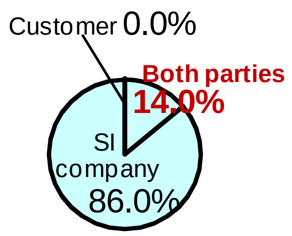
found the risks.
- Senior managers and salespersons are responsible when the troubled projects occurred due to all the other causes. (Since less process is defined for them than the PMBOK for the PMs, we thought it is difficult to breakdown responsibility for troubled projects to either senior managers or sales persons at present. Thus, we categorize them to a single party in this thesis.)

Moreover, the following procedures were used to avoid biasing the investigation and analysis.
- Twenty members in the sectional meeting of IPA, who were from different IT companies and offered the cases, executed analysis and evaluation independently without any interference with each other.
- The analysis was summarized after all of the results were reviewed in the final sectional meeting. We obtained the final results by eliminating rooms for intentional data operations by the reviews.

4.3.3 Analysis of Responsibility

We analyzed the breakdown of responsibility for the cases between the customer the SI company. As the results of analyzing 86 cases other than SPP cases, SI company was responsible for 86% (74 cases) of the total 86 cases other than SPP and the both parties were responsible for approximately 14% (8 cases) of the cases. On the other hand, when 107 SPP cases are considered, 28% (30 cases) of the cases were the SI company's responsibility and both parties were responsible for 72% (77 cases) of the cases (Figure 4-2).

Break down of resposibility for 86 cases other than SPP			Break down of resposibility for 107 SPP cases		
SI company	Customer	Both parties	SI company	Customer	Both parties
74 cases	0 case	12 cases	30 cases	0 case	77 cases



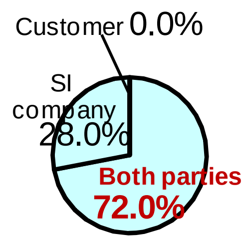


Figure 4- 2 Results of responsibility analysis of customer or the SI company

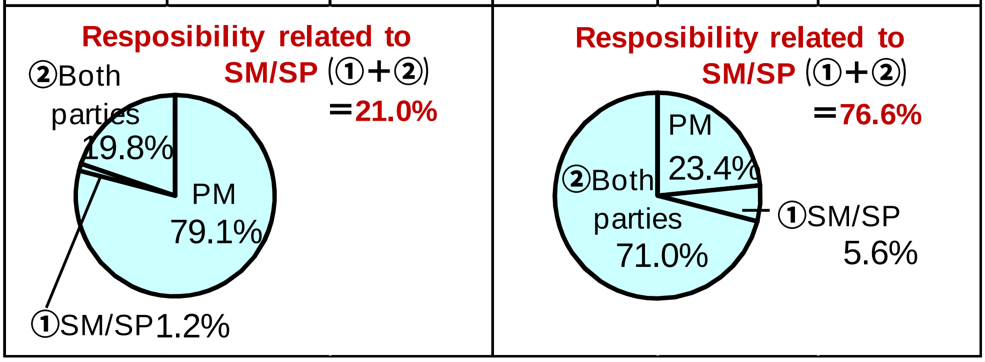
We also obtained another set of results by analyzing the breakdown of responsibility in the cases within the SI company to the PM, the senior manager and salesperson, or to both parties. The results are also shown by separating total 193 cases to 2 categories, the 107 SPP cases and the other 86 cases, in Figure 4-3.

In both categories, the PMs were related to more than 90% of the SPP cases. This reconfirms that activities including enhancing the PMBOK, which have been focusing on the PMs, are important.

However, as far as the SPP cases are concerned, although the senior managers and salespersons were responsible for approximately 6% of the cases, both groups, the senior managers and salespersons and the PMs, were responsible for approximately 71% of the SPP cases. Thus the senior managers and salespersons were related to more than 76% of the SPP cases. On the other hand, when we focus on86 cases other than SPP, the both parties were responsible for only 21%.

This says that we cannot neglect contributions to the SPPs by the senior managers and salespersons, and we must think it as much important issue to develop countermeasures practiced by them as the legacy activities focusing only on the PMs.

Break down of resposibility for 86 cases other than SPP			Break down of resposibility for 107 SPP cases		
PM	SM/SP	Both parties	PM	SM/SP	Both parties
68 cases	1 case	17 cases	25 cases	6 cases	76 cases



(Note) SM; senior manager, SP; sales person

Figure 4- 3 Break down of responsibility for troubled projects

For example, the following cases were the responsibility of both groups.

- Failure of acquiring order of a legacy system migration using a software package (PKG) (Upper development phase [1-24]).

A salesperson prioritized acquiring an order over other solutions and proposed a system migration using PKG instead of meeting the customer requirement of achieving compatibility with a legacy system. After the gaps between the PKG and what the customer intended came to light later, additional development for customizing the PKG was required that led to a significant delay and cost overrun. In this case, not only was the PM responsible for reporting the problem to the senior manager too late, but the salesperson was also responsible for failing to ask the PM to ensure the requirements and costs before the contract.

- PM failed to escalate occurring risks during the development to the senior management (Middle development phase [1-25]).

A PM failed to present a scope change problem to the senior manager, who only had functional organizational experience and could not be expected to advise the PM with a solution. Although the PM tried to manage the issue solely, quality, cost and delivery problems occurred later. In this case, not only was the PM responsible for failing to report the problem to the senior manager, but it was also the senior manager's responsibility to provide the usual support and follow up for field projects.

- Over budget by a magnitude of increased man months (Lower development phase [1-26]).

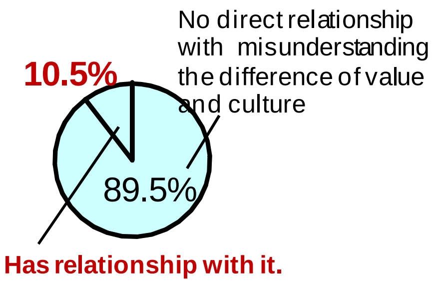
The senior manager approved a fixed price contract in spite of insufficiently defined customer requirements, whose business area was brand new for the SI company. The SI business did not pay, because required work increased in the lower development phase. In this case, there observed not only the senior manager's responsibility for forcing a contract in neglecting a PM's alert, but also the PM's responsibility for neglecting to report the problem to the senior manager despite earlier alert had been possible to forecast the increasing work at upper developing phases.

4.3.4 Analysis of the Relationship Between Cases and Misunderstanding the Differences of Value and Culture

Figure 4-4 shows the results of analysis on the relationship between cases and misunderstanding the differences of value and culture.

When 86 cases other than SPP are considered, only around 10% of the cases occurred in the environment of misunderstanding the differences of value and culture. However, as far as SPP cases are concerned, the number increased and exceeded 60%. For example, the following cases became SPPs, in the environment of misunderstanding the differences of value and culture.

86 cases other than SPP		107 SPP cases	
Has relationship with mis-understanding the difference of value and culture	No direct relationship	Has relationship with mis-understanding the difference of value and culture	No direct relationship
9 cases	77 cases	70 cases	37 cases



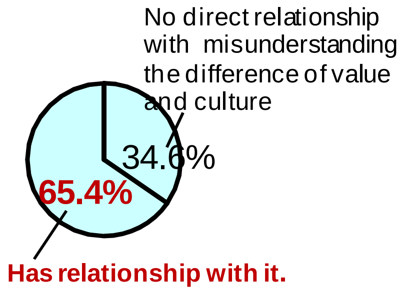


Figure 4- 4 Analysis of the relationship between troubled projects and misunderstanding the differences of value and culture

- Delay of service starting caused by a delay of fixing the requirement scope (Upper development phase).

While the SI company worried about the risks of delays and quality defects caused by shortening the rest of the development period due to the delay of fixing the scope, the customer feels less risk due to the delay of fixing the scope.

- Even though a system was developed faithfully to the requirements, the customer's business stopped for a long time, due to the length of time required to recover the system's operational defects (Middle development phase).

While the customer expected that the SI company assured both the stability of the system and its operation, the SI company thought it was sufficient to design only to the customer's budget and scope requirements.

- Many specification problems occurred due to different understandings of assuring compatibility with legacy system (Lower development phase).

While the customer believed the requirement included all the legacy system functions, the SI company did not think it was necessary to develop a system scope that exceeded what was written in the requirement document presented by the customer.

4.4 Consideration

Based on the discussion above, the following two conclusions can be drawn regarding SPPs.

1) There are SPPs that cannot be prevented by the marginal capacity of a PM.

In the analysis shown in Figure 4-3, while approximately 23% of the SPP cases were the complete responsibility of the PM, those that were also the responsibility of the PSs (the senior manager or the salesperson) numbered approximately 77% of the total SPP cases.

Although there have been a number of discussions focusing on the PM, such as PM processes described in PMBOK, Figure 4-3 demonstrates that it is difficult to avoid most SPPs by only focusing on the PM. In fact, the PMBOK recommends that a PM asks stakeholders for project support, such as risk identification. However, the SPPs cannot be prevented when the asked stakeholders, including the senior manager, neglect the PM's requests or alerts.

2) SPPs are difficult to prevent without the participation of the PSs.

As previously mentioned in the analysis, the following problems are included in the SPP cases.

- Problems that relate to the overall business activities of the SI company.

As mentioned in the former section, the SPPs which were also the responsibility of the PSs included problems related deeply to the overall business activities of the SI company, such as acquiring orders and contracts, or communications between the PM and the senior managers. Thus, the problems do not exist solely within the scope of responsibility of the PM's management and cannot be resolved without also focusing on the PSs (as shown in Figure 4-1).

- Problems that exceed what the PM can control.

As discussed in the former section, more than 60% of the SPPs occurred due to misunderstanding the differences of value and culture. The actual SPP cases included problems due to the different viewpoints of the customer and the SI company. The PM cannot resolve such problems solely, since the PM is not in a position to select the customer. Thus, it is difficult to prevent the SPPs due to such problems without the leadership of the PSs.

4.5 How to Move Forward

Even the above results are given, it is difficult to promote developing countermeasures to prevent SPPs, if we cannot provide any practical recommendations of strategies that can be executed by stakeholders including the PSs.

To cope with this issue, we also consider that the countermeasures can be developed by the following categories.

1) Countermeasure practiced by stakeholders inside SI company

It is thought to be a countermeasure to prevent outbreaks of SPPs for the sales persons and the senior managers are assigned the following role and responsibility and practice improvement activities by cooperating with PMs.

Sales persons; role of evaluating difference of value and culture between the PMs and the customers.

Senior managers; responsibility of judging signs of SPPs and selecting countermeasures.

However, it is possible that such improvement activities by the stakeholders may not continue, if the companies depend only on their volunteer activities.

In order to decrease problem projects in the long term by continuing such activities, it is necessary to consider further countermeasures which the top management executives practice from a point of view of the total corporate organization. In such sense, it may be one of the countermeasures for the management executives to keep a permanent reward policy [4-19].

Attachment 4-1 shows the example of the countermeasures which can be practiced by PMs, senior managers and sales persons and also be supported by the management executives to prevent the outbreaks of SPPs.

2) Countermeasures practiced by stakeholders including customers

It is probable that there can be hidden risks or risks which hide their self, if PSs including customers do not participate in a project. Thus PSs are required to have some proper processes to make such risks to come to light.

Attachment 4-2 shows a example of the countermeasures which can be practiced by customer, senior manager and sales person to avoid and mitigate such project risks.

4.6 Conclusion

In this thesis, we showed that the PS (the customer, the senior manager or salesperson) is responsible for more than 70% of all of the SPP cases collected by IPA. It has also been shown that more than 60% of them occurred due to misunderstanding differences of value and culture.

From these quantitative results, the following conclusions can be drawn regarding SPPs:

- There are a significant number of SPPs that cannot be prevented by the marginal capacity of the PM.
- Because SPPs include problems that relate to the overall business activities of the SI company or problems beyond the PM's control, it is important for PSs, including the senior manager and the customer, to take an organizational approach.

We also explained that clarifying the process standards for the PSs is no less important than that of the PM.

Moreover, in order to decrease the number of SPPs in the future, we recommended practical countermeasures for PSs as well as the management executives.

Since particularly the stakeholders are strongly related to SPPs as discussed in this chapter, it is very probable that the SPPs may occur even if PMs practice sufficient management in general IT projects by using the method mentioned in the former chapter. For example, phenomena caused by activities practiced by the stakeholders in early project phase may cause SPPs at the final phase through complicated causal chains produced by the phenomena. It is apt to be too late to take proper countermeasures to prevent SPPs, since it is difficult to identify such early signs of the phenomena. We discuss about the problem next, by practicing additional case analysis.

Attachment 4-1

Example of Countermeasure Practiced by Stakeholders Inside SI Company

Based on the above discussions, it is thought to be countermeasures for organizations of SI companies to assign relevant missions to the following stakeholders for avoiding outbreaks of SPPs.

1) PSs
2) the management executives

A specific example is explained below.

(A) Mission of PSs

It can be a countermeasure to prevent SPPs for the organization of the SI company to assign PSs the following role.

- Sales person (role of evaluating difference of value and culture between the PM and the customer):

The sales person takes a role to evaluate difference of value and culture between the PM and the customer, since he/she is in the best position to know about the customer. Thus he/she also has to propose to the senior manager assignment of a PM at the project initiation or change of the PM at the project execution.

- Senior manager (responsibility of judging signs of SPPs and selecting countermeasures)

In order to achieve this responsibility, the senior manager has a responsibility of the departmental communication management, which makes PMs to escalate problems easier. For example, there have been reported a case that it is effective for the senior manager to have a democratic management style [4-10] and to be a communication hub within the department [4-11] , from the point of view of preventing problem projects and keeping stable business performances [4-12].

The senior manager also has a responsibility of judging signs of SPPs by himself/herself, not by transferring the work to the PM or the sales person, as far as problems relating to the overall business activities of the SI company are concerned, including problems of trade off judgment between business of contracts or acquiring orders and risks. Furthermore, the senior manager has a responsibility to make final judgments regarding the PM’s marginal capacity or change of PMs, in corporate with sales persons as far as the difference of value and culture between the PMs and the customers are concerned.

Since it became more usual cases that resources of PMs become lacking and less experienced PMs are assigned to projects, it is thought to be more important to organize scheme, where not only PMs but also senior managers and sales persons cooperate with assigning roles or responsibilities to individuals in order to practice improvement activities regarding preventing the SPPs.

An example of such an organized scheme named P2SM [4-13] is shown in Figure 4-5.

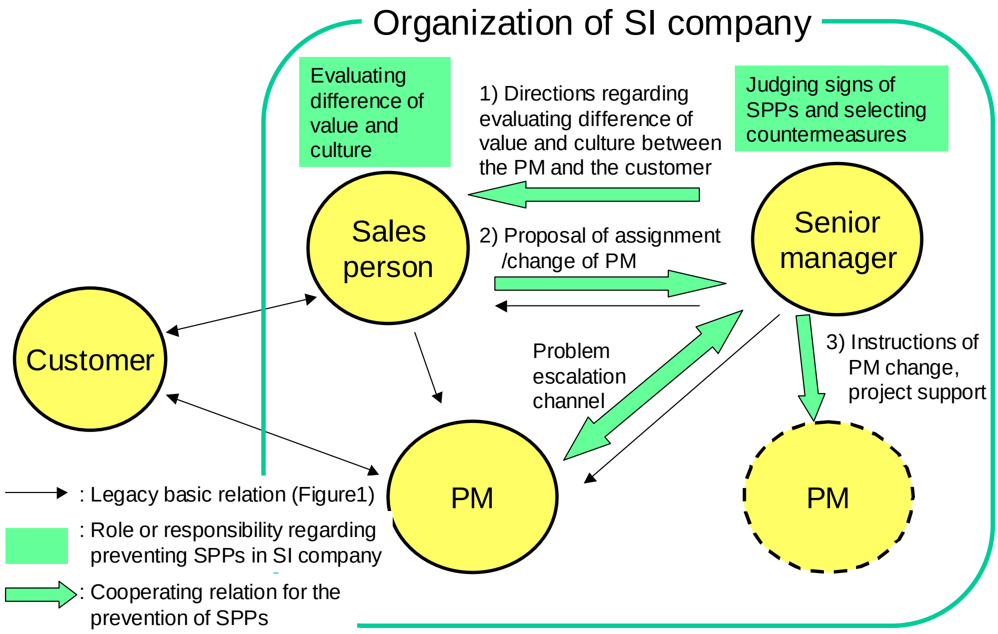


Figure 4- 5 Cooperated scheme P2SM practiced by PSs in SI company

(B) Mission of the Management Executive

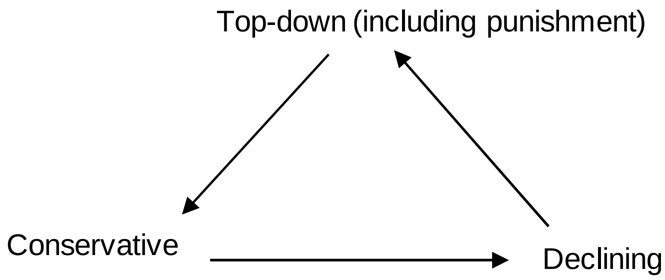
PMOs (Project Management Offices) have started to be organized in many IT companies since early 2000s [4-14] [4-15] [4-16] [4-17] [4-18].

According to surveys [3-6] practiced by IPA, most of the PMOs were organized by top-down orders from the management executives to empower corporate governance by assessing project risks, when outbreaks of the problem projects were observed. The surveys analyze that members in the PMOs are apt to be reactive to the management executives and there also can be observed frictions between the PMOs and the business units which include PMs, senior managers and sales persons. The surveys could not conclude that it is sufficient to continue decreasing problem projects only by organizing the PMOs.

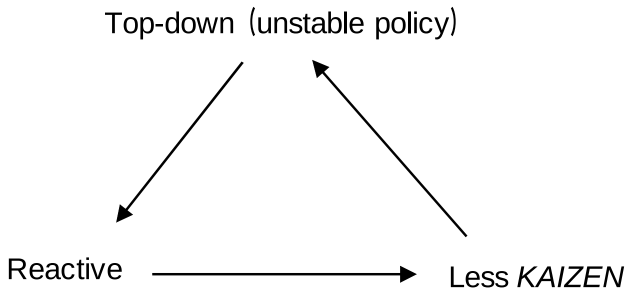
Therefore, the author further tried to identify what are the obstacles, which prevent the year-by year decreasing of problem projects, by further analyzing the surveyed data and comparing the countermeasure practiced by the management executives of SI companies and the continuous improvement activities known as *KAIZEN* which have been practiced at the Toyota for more than 40 years.

As a result, it is clarified that activities of the management executives to punish persons in the business units for causing problem projects and change organizations of the PMOs frequently are apt to develop negative spirals in the business units and the PMOs as illustrated in Figure 4-6.

Consequently, it is thought to be necessary for the management executives to keep a stable reward policy [4-19] for the business units and the PMOs, to stop the negative spiral and change it to the positive spiral as illustrated in Figure 4-7.

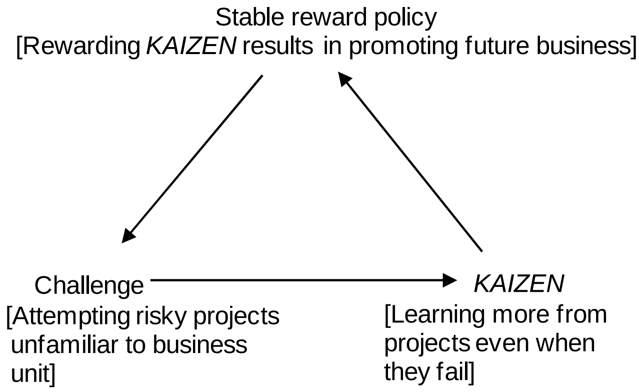


a) Negative spiral of business unit

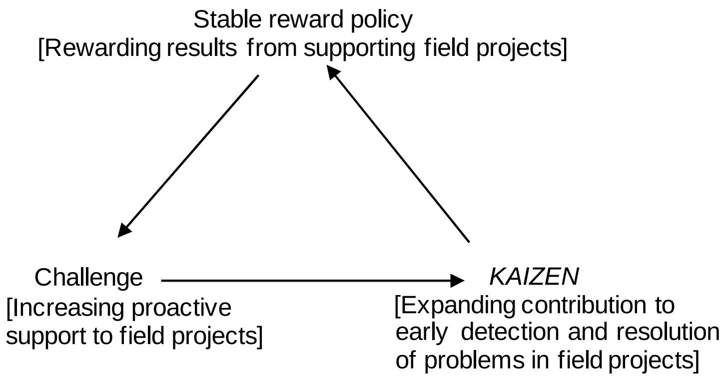


b) Negative spiral of PMO

Figure 4- 6 Negative spirals in business unit and PMO



a) Positive spiral of business unit



b) Positive spiral of PMO

Figure 4- 7 Positive spirals of business unit and PMO

Such a countermeasure practiced by the management executive promotes improvement activities of the P2SM in the business units mentioned before.

This also promotes proactive improvement activities by members in the PMOs.

Therefore, the policy of the management executives is expected to decrease the problem projects year-by-year, just like the Toyota has been decreasing defects in its products for more than 40 years.

Attachment 4-2

Example of Countermeasure Practiced by Stakeholders Including Customers

Based on the analysis discussed above, SPPs is highly possible to occur, if there are misunderstandings in the differences of value and culture. In order to clarify when such situations are apt to occur and how they influence the risks, we will examine the following case study.

(A) Typical Case Study Where Risks are Apt to Hide Themselves or are Hidden

Companies aim to minimize risks and maximize profits due to economic principle. We call it a Buyer and Vendor relationship when both the Buyer and the Vendor each aim to achieve individual optimization. We show the following process which is apt to occur if the Buyer and Vendor relationship exists.

<Pre-project>

1) Starting contract negotiation under the Buyer and Vendor environment.

The buyer aims to complete contracts to transfer risks to vendor. On the other hand, the vendor tries to avoid the risks.

2) Extracting potential risks.

The buyer does not disclose its known risks actively since it fears the estimated costs will become higher due to those disclosed risks. On the other hand, the vendor has no obligation to disclose its known risks actively unless the disclosure is beneficial to it, even if the vendor eventually found risks which are harmful to the buyer.

3) A project charter (the contract) is agreed upon in such situation.

<From project start to its completion>

4) Since the buyer has successfully transferred the risks to the vendor by the contract, it has no obligation to actively follow the status of occurring risks. Moreover, the vendor takes a higher priority to focus on its own critical problems rather than reporting problems to the buyer side, even if the vendor found the problems eventually.

5) Sometimes major defect problems, cost overruns or delays occur when undetected risks occur in the lower development phase.

In the case of the Buyer and the Vendor mentioned above, risks tend to be as follows.
- Risks hide themselves: Because of insufficient understanding, risks are not recognized and continue to hide themselves until they appear in the lower phase.
- Risks are hidden: If one party does not have the same values of the other party and recognized risks are out of the scope of its own values, it may not disclose the risks to the other party, if the disclosure is not beneficial to it.

(B) Suggestion of Ideal Process to PS

Let us consider below how the problem of the hiding or hidden risks change, if the relationship between the customer and the SI company changes from the Buyer and Vendor to partners to fight with project risks.

In this case, the following process can be executed if the PSs actively participate in projects.

<Pre-project>

1) The PSs explicitly make sure with each other that a Partnership has been constructed.
2) The PSs identify risks cooperating on equal footing with each other. (They can ask a PM to support; however the PSs should be responsible for the final outcome.)
3) The PSs agree upon a project charter after reconfirming that no risks remain hidden.

<From project start to its completion>

4) The PSs follow the status of risk occurrence.
5) If risks occur that should have been pointed out in pre-project phase, the PSs determine the root causes regarding why the risks could not be identified.
6) The PSs decide whether they should continue the Partnership or not by examining the root causes at the project termination. In deciding to continue the Partnership, improved methods to identify risks should be made clear, mutually agreed upon, and the PSs should use the outcomes as lessons learned for future project charters.

Features of the process mentioned above are as follows:
- Both parties, the customer and the SI company, try to resolve problems by using a win-and-win scenario, understanding each other’s positions, based on the Partnership. This requires the PSs to be much more involved in executing projects at step 4) than the process mentioned in the former section.
- Hidden risks by intentional concealment may be excluded by step 6), where not only the Partnership, but also the future business, may not continue when

any hidden risks are clarified.

- As for risks that hide themselves due to poor risk identification, improved methods of identifying risks for future projects may be produced by the actions from steps 5) and 6). Such risks may also decrease while the PSs gain experience.

As this discussion demonstrates, this process is thought to contribute to avoiding the hiding or hidden risks with more certainty than the process mentioned in the former section. In this respect, we believe that this is an ideal process for PSs.

The ideal process described above is thought to be what the PSs should do, in the sense that it prompts them to identify and share risks earlier.

The authors suggest that PSs execute a series of the above process, not implicitly as before but by defining them clearly as described above, to prevent SPPs.

Chapter 5

Derivation of a Model to Identify Major Risks

5.1 Introduction to This Chapter

The death spiral called the "devil spiral", which is a phenomenon caused by defective quality, delays in progress and lack of manpower, is most often observed in the lower development process of a SI business environment, despite the popularity of the PMBOK. Although it is reported by Haihara, [5-1] that serious problem projects (SPPs) accompanied by the devil spiral occurred more than 20 years ago, the same problem projects still occur even at present.

Adverse effects caused by SPPs include the following.

- Customer companies: opportunity loss due to service delay, degradation of social reliability due to defect in service.
- SI companies: making a loss or a considerable decrease in profit, opportunity loss due to resources allocated to recovering the troubled project.

It is important to detect symptoms of the SPPs to prevent such adverse effects. Thus, in this thesis we set our goal to make it easier to identify major risks by distinguishing phenomena that are sources of future SPPs from phenomena observed in actual field projects.

However, SPPs are seldom due to a single causal phenomenon. Most SPPs are caused by multiple phenomena, which occur through out the upper development process and spread to the lower process, and the relationships between the phenomena are extremely complicated. In such a situation, it is difficult to obtain a bird's-eye view that indicates the origin of a phenomenon that is occurring in a current project, and what problems the phenomenon may cause in future project phases.

For example, in the middle development phase shown in Figure 5-1, when senior managers discover that a customer requires many explanatory documents from a PM, it is difficult for them to determine the background to the phenomenon and the problems involved, even if they suspect that something unusual is occurring. Consequently, it is possible for them to under-evaluate the risk of future SPPs and to fail to prevent SPPs from occurring, because the countermeasures taken in the lower development phase are too late.

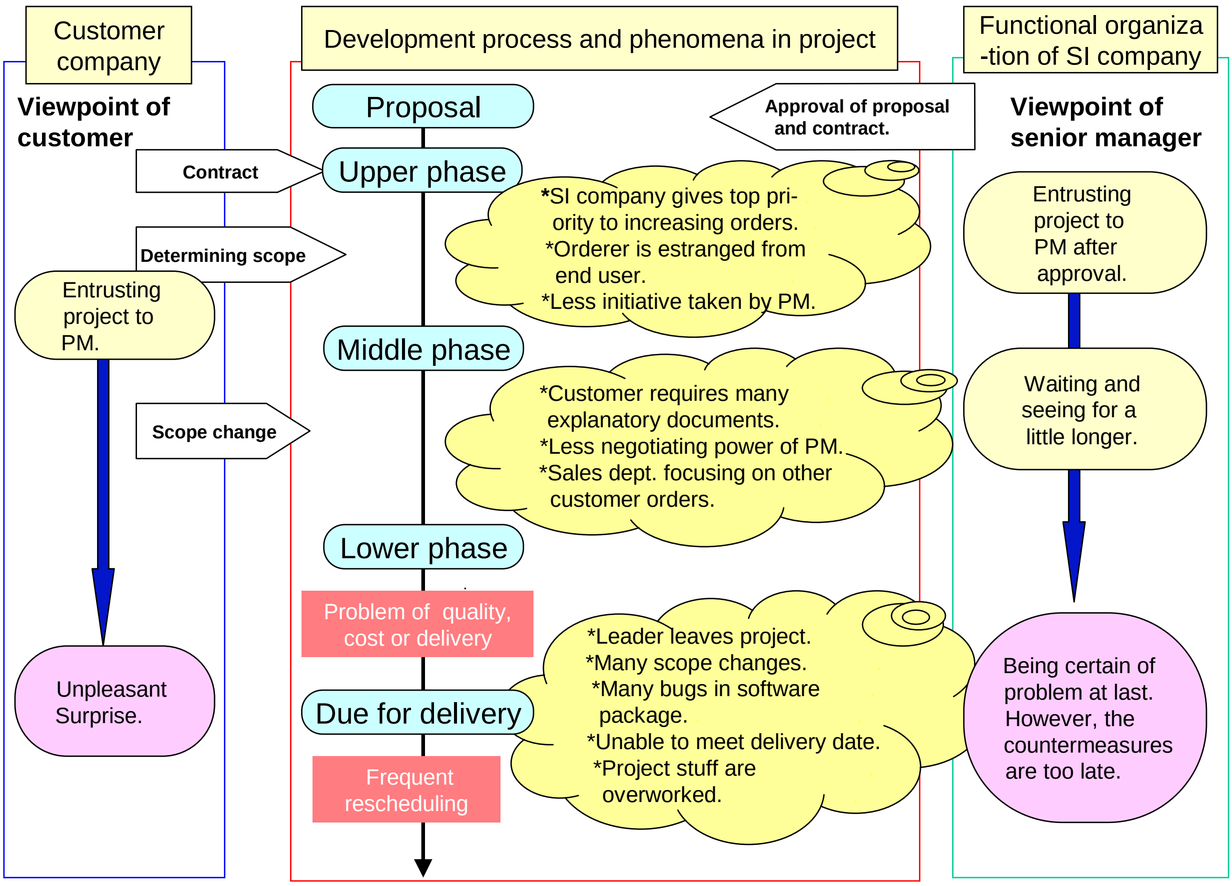


Figure 5- 1 Sample phenomena that occur in SPPs of SI firm

Thus, it is important to construct a model that offers a bird's-eye view of the causes and effects of phenomena in the earlier phases in Figure 5-1.

Regarding this issue, Risk Identification and Risk Analysis in the PMBOK 3rd edition [1-9] describes methods such as information gathering techniques including interviewing and risk probability and impact assessment. However, no detailed methods are given except that of asking for the support of knowledgeable persons or for expert judgment.

Since the 3rd edition was published, there have been studies on more detailed methods that enable the construction of models of the causes and effects of phenomena. In particular, modeling studies using Bayesian networks (BNs) [5-2] have been conducted. However, the types of causal relation considered in the models include only the noncyclic type [5-3] [5-4], and cyclic types such as the devil spiral have not been discussed.

Looking at more basic researches, there are general problem-solving methods including Apollo root-cause analysis using a "caused by" tree [5-5], a method proposed by Kepner and Tregoe [5-6] and a method using fishbone diagrams [5-7]. However, similar to the BN methods, they have not discussed the cyclic causal phenomena like the devil spiral in SI environment.

Regarding recent researches on project failures in SI environment, McManus & et al. [5-8] categorized critical causal factors (CCFs) of failed projects into either management or technology and they report that the management issues accounted for 65%. The results are nearly equal to our experiences and we think their efforts should be evaluated high. Kappelman et al. [5-9] chose 17 most important early warning signs (EWSs) among original 53 EWSs by scoring importance of each EWS through interviewing experts and got a final list of 12 EWSs by combining several of these 17 EWSs. They also assigned the 12 EWSs to 3 categories (technology, people and process) but they found no technology-risk. This excellent result is quite the same idea that we have. There have been other researches on project failures in information systems such as Taylor [5-10] or Reich [5-11].

However any of these researches had the following two problems.

- First, none of these researches could clarify quantitative relationships between each individual event (which includes phenomenon of CCF or EWS) and actual SPPs.

This made one in an actual field project difficult to be sure whether there is any major risk or not. There are many cases SPPs did not occur even if a single CCF or EWS occurs. For example, even if an EWS of "Lack of top management support" occurs, SPPs are seldom observed particularly in situation where the project has excellent customer trust and sufficient development capacity. This might be a reason why these researches could not clarify the quantitative relationships.

- Second, there has been less research that focuses on bad influences caused by the chain of plural events.

It is very probable that SPPs occur particularly when the chain of plural events becomes to form a cyclic chain, since impacts of the chain's risk often become huge. Nevertheless, less research has moved forward to focus on such chain of plural events, since events including CCF or EWS are viewed independent each other.

Robertson & Williams reported that they found causal chains of plural events (loops) in a failed SI project in their paper [5-12]. Objective of this paper is to get lessons learned by analyzing causes of the troubled project using method named Cognitive Mapping. In this thesis, causal relations among events are described by categorizing events to 4 types (main outcomes, external events, management decisions and the others). They tried to detect the root causes of the failure by describing the Cognitive Mappings (detailed relations of the causal chains based on such categorized events), after the failed project was completed.

However, there can be observed no attempt to expand their objective of introducing the Cognitive Mappings from acquiring lessons learned to identifying major risks. The reasons can be thought to be as follows. That is, it is possible to execute the detailed and complicated analysis of a single failure project based on the event categorization mentioned above, after the project completion, if their objective is only to acquire lessons learned. However, if their goal is to identify major risks, then it is required much more to achieve simplicity and clarity of the method, so that the method can be widely introduced to many general projects. Thus, it is thought that it is difficult to introduce the Cognitive Mapping to on-going projects, where quick decisions of identifying major risks are required within limited times.

Moreover, their findings including the detected loops are extracted from just a single failure project and there can be observed no attempt to make the lessons learned to use as universal models to identify major risks of general SI projects in their paper.

It is difficult to conclude that legacy methods offer a model for identifying the phenomena of SPPs in earlier development phases and for taking countermeasures before the occurrence of SPPs. The reasons for this are explained below.

1) Existence of some cyclic causal phenomena was pointed out by Haihara and Robertson & Williams. However, the scope is restricted to the lower phase or at least there observed no attempt to use the phenomena as a tool to identify major risks.

2) In previous studies applying BNs, there is a discrepancy between the model and the actual causal relations including the cyclic type, because the studies have focused on noncyclic relations, even if there are no restrictions such as that in 1).
3) Even when an SI company produced a model that appeared to closely reflect actual causal relations, it has been difficult to prove the sufficient universality of the model for its application in general cases because of the difficulty in obtaining actual data from other SI companies.

From the above consideration, it is possible to conclude that no practical and universal model has yet been acknowledged.

Therefore, many SI companies, even when phenomena indicative of future SPPs occur, can only take countermeasures within the scope of the present. This is thought to be one reason why SPPs including the devil spiral still occur.

Also, even after surveying the most recent PMBOK 4th Edition [1-10], we can observe no new method to meet with such issue.

With the above background, we have to develop a model to identify major risks with the following three features.
1) The scope of the model covers not only the lower phase but also the whole project life cycle including the middle and upper phases.
2) The model includes events that have a strong relation with SPPs and does not exclude events whose relationship is cyclic.
3) The model is not only proposed but also its sufficient universality for application in general cases is proved using data of actual SPPs.

Using the model, we attempt to identify major risks by systematically visualizing a bird's-eye view of relationships between events whose phenomena have been difficult to understand.

Specifically, we construct a causal model in the next section and clarify its universality by investigating the correlation of the model with cases of actual SPPs in the successive section 5.3.

5.2 Bird's-eye View Model of the Causes and Effects of SPPs

We decided that it is necessary for the model to satisfy the following two conditions for it to have universality and practicality.

1) The model should be constructed to include events that have a cyclic relationship and have actually occurred at least once.

2) The model can be applied to explain many cases of SPPs.

We will discuss the proof of condition 2) in the next section (Actual SPP Cases and Proof of Model).

To satisfy condition 1), we constructed the following cyclic model based on events with the idea that a group of events with a cyclic relationship in an earlier phase of an SPP changes its nature when the project proceeds to the next phase.

The events and the idea are based on the author's experiences in IT projects for more than thirty years, including domestic projects for developing operating systems or large scale on-line mission critical systems for various users in various firms, international projects to develop systems by introducing brand new technologies from foreign countries, and programs in which more than thirty IT projects are conducted. Some of them can be referred to at professional articles in the Appendix.

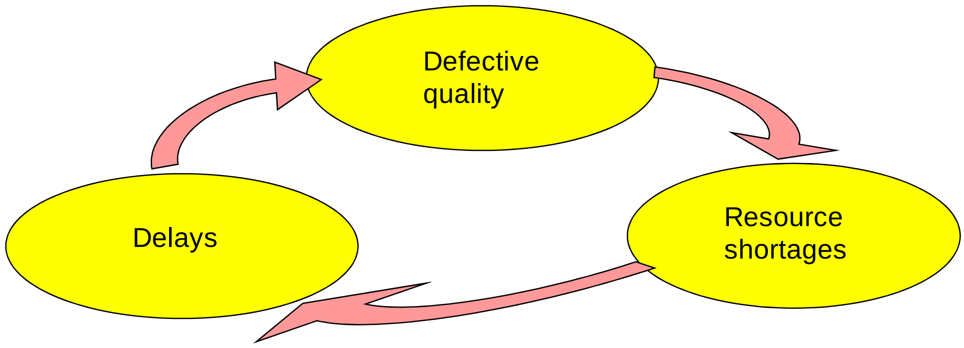
5.2.1 Phenomenon of Devil Spiral

In the lower phase of system development, which includes testing, one of the three problems, namely, defective quality, resource shortages and delays, described in Figure 5-2 (A) often occurs first.

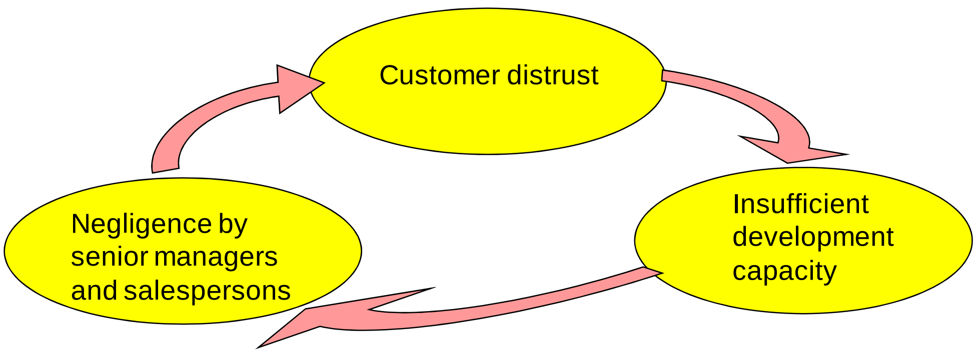
Then the three problems occur one after another, and this vicious cycle continues. This spiral repeats itself and the problems eventually spread to the entire system. This vicious cycle is the devil spiral.

5.2.2 Middle Development Phase

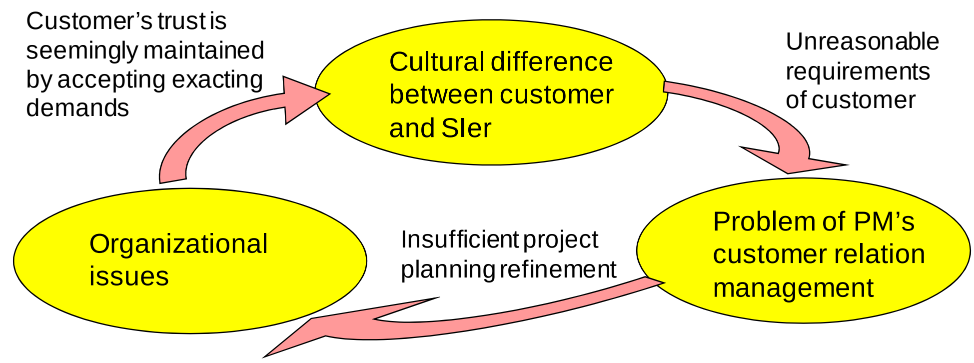
The event of defective quality shown in Figure 5-2 (A) can be fixed earlier and may not cause a major problem if bugs originate from programming. However, if the origin of the problems is from the product design, we should redesign and remake the product and test it again. This requires a long time and causes significant cost overruns. In many cases, the cause of major problems is insufficient design capacity in the middle development phase.



(A) "Devil" spiral in lower development phase



(B) "Death spiral" in middle development phase
(including detail design)



(C) "Death spiral" in upper development phase
(including proposal phase)

Figure 5- 2 A bird's-eye view model of the causes and effects of SPPs

One factor that prevents the PM immediately reporting to the customer and taking countermeasures against the delays is often the customer distrust of the PM.

Moreover, even if the insufficient design capacity or the customer distrust is reported to senior managers and salespersons, they sometimes do not react sufficiently. Particularly, in a growing market with continuous good sales performance, where salespersons tend to take more initiatives in the organization than PMs, the report is often neglected, because taking a new order tends to be more attractive than dealing with events in a current project in such a market.

If the negligence by the senior managers and salespersons continues, the customer distrust increases and the customer becomes doubtful about the successful completion of the project.

The concerned customer requests the PM or designers to submit additional documents such as more detailed design documents or progress reports. However, this imposes an extra workload on the PM and the designers, and worsens the problem of insufficient design capacity.

Because the PM and the designers are eager to honestly respond to customer requests, they become too busy to ask senior managers or salespersons for help. As a result, their negligence continues. In the end, a less-skilled PM spends his/her work time tackling problems. This situation once again increases the customer distrust.

When the project proceeds to the lower phase through the devil spiral shown in Figure 5-2 (A), problems of quality, resource shortages and delays arise. In other words, the spiral described in Figure 5-2 (B) is thought to be one of the causes of the devil spiral in the lower phase.

5.2.3 Proposal Phase

The customer distrust shown in Figure 5-2 (B) rarely occurs when mutual understanding between the customer and PM is maintained. In contrast, the customer distrust is likely to result when there are cultural differences between the customer and the system integrator (SIer) due to insufficient mutual understanding. Cultural difference is defined as a situation where shared project risks or business values are lacking [3-6].

The PM has a huge regular workload including coping with the customer’s various demands and negotiating the required scope. In addition, in a multicultural environment where understanding the customer’s sometimes unreasonable demands itself is difficult, greater project management capability is needed. If the PM’s capability of managing customer relations is not sufficient, the project scope cannot be fully defined or negotiated. This results in an unclear project plan with insufficient refinement of the cost and schedule baselines.

Under the management of the SIer, in which acquiring orders takes priority over other issues, sales departments tend to take the initiative and accept the customer’s exacting demands, which forces the PM to draw unreasonable cost and schedule baselines, and to agree a fixed-price contract. This is an organizational issue.

In this case, problems raised by the PM are often neglected, because the project seems to maintain customer trust by accepting all of the customer’s demands. However, the fundamental issue of cultural difference remains unresolved.

This cycle in Figure 5-2 (C) continues until the phase proceeds to the middle development phase. As mentioned above, if no countermeasures are applied, this spiral shifts to the cycle in Figure 5-2 (B) and ultimately to that in Figure 5-2 (A). This transition sometimes leads to major problems. In a sense, this transition from (C) to (A) in Figure 5-2 is the growth model of the devil spiral and we call Figure 5-2 as a bird’s-eye view model of the causes and effect of SPPs.

5.3 Actual SPP Cases and Proof of Model

The above causal model is based on over 20 years of experience in the author's field of development management including large-scale information systems and operating systems. However, it is not clear whether the model is universal enough to apply to the general field projects.

The following discussions are to verify the universality of the model.

5.3.1 Method of Specifying SPP Cases

We obtained information regarding troubled projects from a sectional meeting named Project *MIERUKA* held at the IPA. The members (20persons) of the meeting were from different Japanese IT companies and were either veterans of the project management of large-scale systems or key persons of the Project Management Office, some of whom have led the recovery of many troubled projects.

Cases of troubled projects were recorded by the members as a series of facts including how the projects became troubled, what countermeasures the PMs took and the outcome of the projects (Figure 3-8 shows a sample case). 193 cases were summarized and disclosed [3-7] [3-8] [3-9].

Although the cases include projects with minor problems, we only considered SPPs from cases with a major impact. Specifically, we defined the criteria of SPPs to be equal to one that was already mentioned at Chapter 4. That is the SPP either caused the delay of the customer service starting plan, resulting in significant quality problems broadcasted by the news media or caused a financial loss due to cost overrun exceeding one hundred million yen. The members who described the cases specified the SPPs and all of the final results were accepted after all members of the sectional meeting reviewed them. Through this process, 107 SPPs were specified by summarizing all cases as problems occurring in the upper, middle and lower phases.

5.3.2 Method of Analyzing SPP Cases

We investigated the relationship between the SPP cases of each phase (upper, middle or lower) and the events included in the death spiral of the causal model.

Cases that are related to the model are categorized into either of the following two types depending on the causal relation with the death spiral.

1) Derivative event: a case that is derived from a death spiral.

2) Accelerating event: a case that accelerates the speed of the death spiral.

As information regarding such relationships are not included in the summary of troubled projects, as shown in Figure 3-8, we asked the members who provided the cases of SPPs to investigate the relationships between the cases and the death spirals. Final results were accepted by all of the members after reviewing all of the result in the sectional meeting, so that there can be no room for intentional data operations.

For example, Attached Figure 5-1(b) shows the results of the investigated relationships between some SPP events and the death spiral in the middle development phase. In this diagram, a case of an urgent request for a scope change (No.1 case in the middle development phase, hereafter described as Middle-1) was identified as an accelerating event, because it accelerated the seriousness of the insufficient development capacity in the death spiral. In contrast, accepting a scope change due to the PM's lack of power in negotiation (Middle-8) was identified as a derivative event, since it originated from the insufficient development capacity in a similar investigation.

Similar results can be obtained for the upper and lower development phases by applying the same process. The investigated results for these two phases are also shown in Attached Figure 5-1(a) and Attached Figure 5-1(c).

5.3.3 Results of Analysis of SPP Cases

The result of analyzing all the SPP cases from the upper phase to the lower phase is shown in Figure 5-3.

About 81% of the SPPs were related to the death spiral. About 47% of the SPPs were derived from the death spiral. It is thought that the occurrence of problems can be markedly reduced if one can reduce the speed of the death spiral.

It is also thought that the growth of adverse effects caused by about 35% of the SPPs can be decreased even after the (accelerating) events occurred if the death spiral is slowed.

From the above results, the proposed causal model is thought to useful to identify major risks of SPPs by clarifying relationship between occurring phenomena and the causal model.

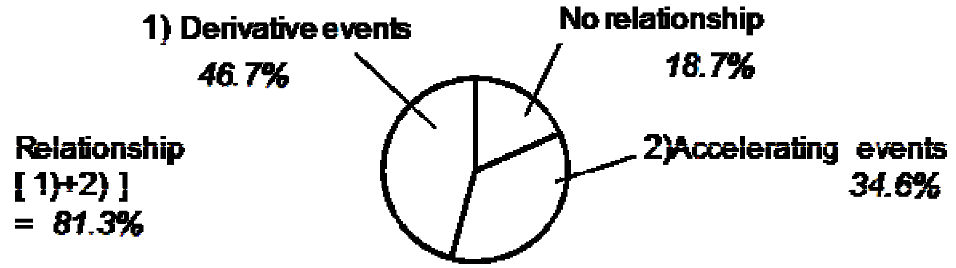
Phase of troubled projects	Number of SPPs	1) Number of derivative events (*percentage*)		2) Number of accelerating events (*percentage*)		Number of events with no relationship (*percentage*)	
Upper phase	39	27	*69.2%*	10	*25.6%*	2	*5.1%*
Middle phase	39	5	*12.8%*	17	*43.6%*	17	*43.6%*
Lower phase	29	18	*62.1%*	10	*34.5%*	1	*3.4%*
Total	107						

Figure 5-3 Analysis of causal relations between SPP cases and the bird's-eye view model

5.4 Method for Identifying Major Risks

5.4.1 Method

From the above results, a derived method to identify events, which involve major risks of future SPP in on-going projects, is described as follows.

< Method>

1) Analyze the relationship between the causal model and a phenomenon that occurs in a project and clarify whether the event is a derivative phenomenon or an accelerating one.

2) If the event is either of them, then identify it as an event that involves major risks of a future SPP.

3) If there is no relationship, then go back to 1) and continue watching and analysis of events, until the project is completed.

In order to get more comprehensive outcomes, it is recommended that the above operations should be made not by a single person but by plural stakeholders (like a senior manager supported by a sales person and a PM).

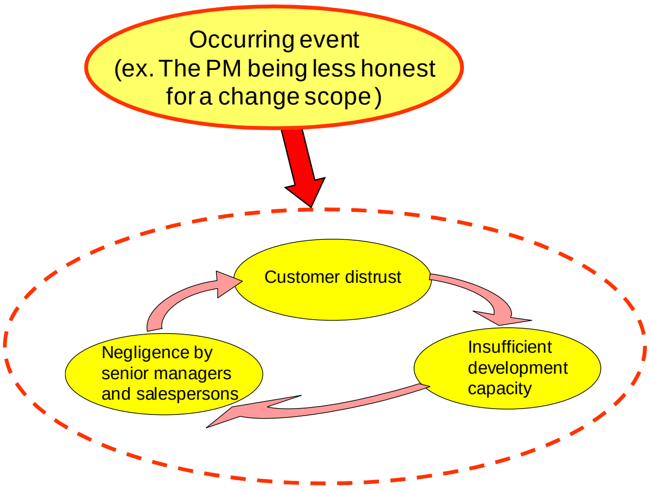
5.4.2 Practical Examples of Applying the Method

Given the methodology mentioned above, it is expected that the probability of successfully avoiding SPPs can be increased by analyzing the relationship between the causal model and phenomena that may occur or have actually occurred, and by taking the following countermeasures.

1) If an event that accelerates the death spiral can be predicted, try to prevent the event from occurring. If the event still occurs, not only take steps to mitigate the effect of the immediate event, but also take countermeasures to prevent the death spiral from accelerating as a result of the event (The risk mitigation process is shown in Figure 5-4). For example, in the middle development phase in the figure, if the problem of the PM being less honest to requests for a change in scope is continuing uncorrected, the senior manager should prevent the acceleration of the death spiral by ensuring that the phenomenon does not cause the customer distrust. A change in the PM can be considered as one of the options.

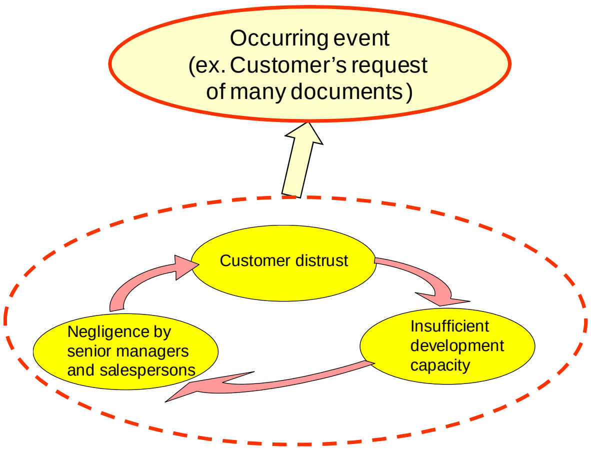
2) If an event occurs that may be derived from a death spiral, not only take countermeasures to reduce damage caused by the event, but also suspect the existence of a death spiral. If the spiral exists, it is necessary to take additional countermeasures to prevent its acceleration and to try to terminate it (The risk mitigation process is shown in Figure 5-5). For example, in the middle development phase in the figure, if the phenomenon of the customer requesting many documents is recognized, rather than only thinking of immediate countermeasures such as supplying additional resources to documenters, also

consider the wider issues of the customer distrust, insufficient development capacity or negligence by senior managers and salespersons, to resolve the problem.



<Process>
1) Identify major risks of SPP using the proposed model (Check each occurring event for whether it accelerates the spiral of the model).
2) If the event accelerates the spiral of the model, then not only take a countermeasure for the immediate event, but also mitigate growth of the spiral.

Figure 5- 4 A process to mitigate impact of accelerating event [an example of the middle development phase]



<Process>
1) Identify major risks of SPP using the proposed model (Check each occurring event for whether it is derived from the model).
2) If the event is derived from the model, then suspect the existence of the spiral of model. And if the spiral exists, then not only take a countermeasure for the immediate event, but also mitigate growing risks of the spiral.

Figure 5- 5 A process to mitigate impact of spiral by derivative event [an example of the middle development phase]

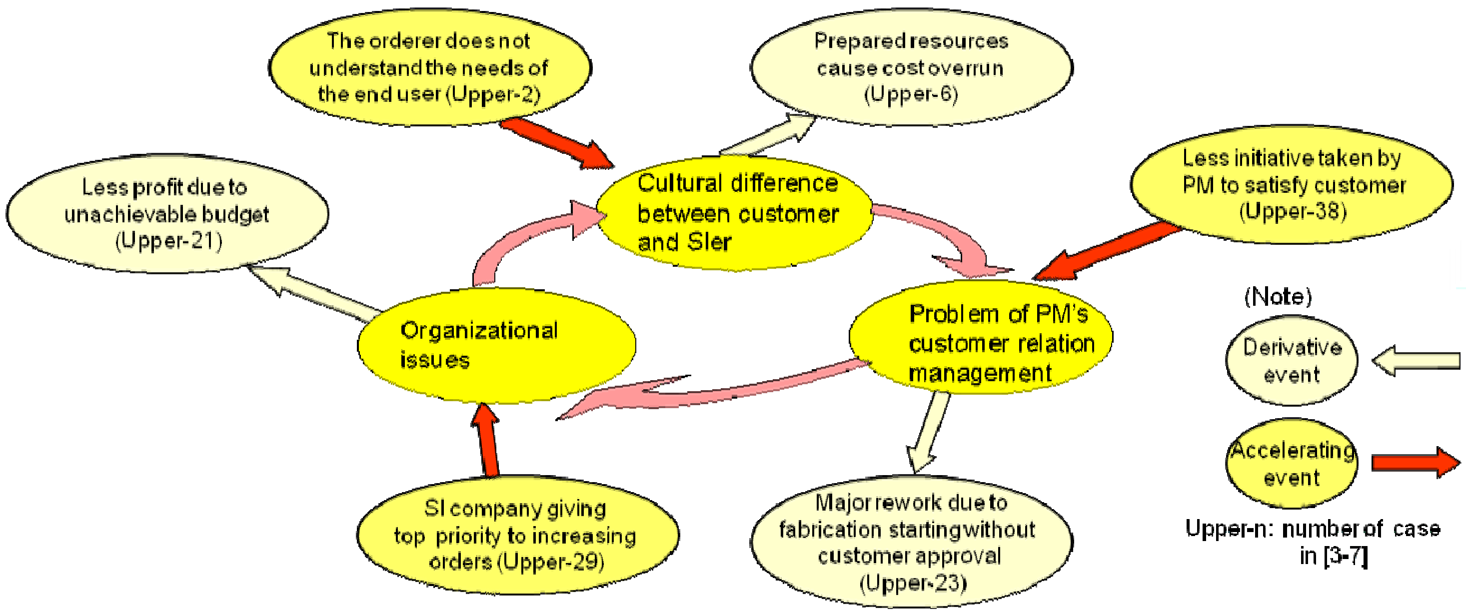
5.5 Conclusion

We clarified that about 81% of actual SPP events occurring in cases of trouble projects summarized by the IPA had a cyclic relationship and were involved in the causal model of SPPs.

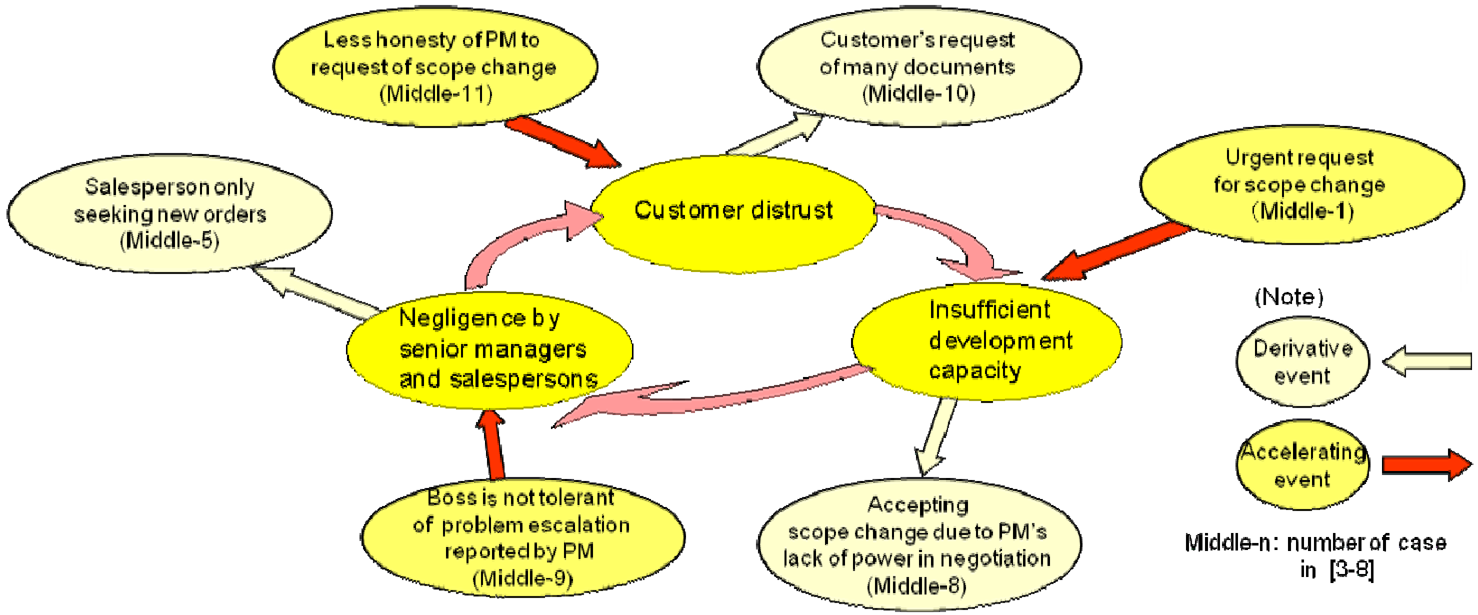
From this result, we conclude that our model can be used for identifying the major risks with more certainty.

As stated before, it is difficult to obtain a bird's-eye view of problems or determine where a phenomenon occurring in a current project originates from and what problems it may cause in future project phases.

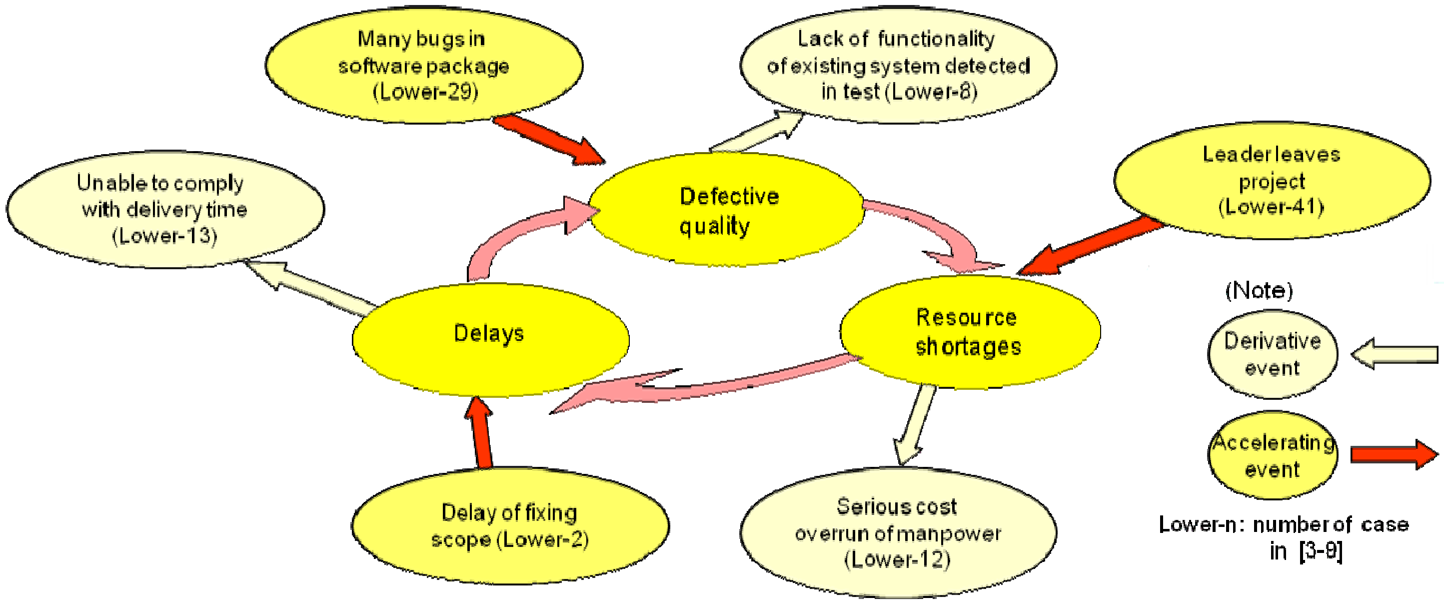
In contrast, as shown in Attached Figure 5-1(a), (b) and (c), it has become easier to understand the causal chain from a point before the phenomenon to a point after the phenomenon for most of the SPPs summarized by the IPA. In this sense, we think that it has become easier to obtain a bird's-eye view.



Attached Figure 5-1(a) Example of relationships between death spiral and SPP events -Upper development phase-



Attached Figure 5-1(b) Example of relationships between death spiral and SPP events -Middle development phase-



Attached Figure 5-1(c) Example of relationships between death spiral and SPP events -Lower development phase-

Chapter 6

Modeling Manageable Dependability

6.1 Introduction to This Chapter

Defects in IT services for mission critical businesses such as financial firms or telecommunication firms (i.e., IT supporting social and economic infrastructure) often negatively influence social and economic activities.

In contrast to embedded IT systems such as those that automatically control hardware equipment, the IT systems associated with social and economic infrastructure are enterprise-level systems with the following characteristics:

- They are able to run large-scale applications exceeding several million steps, including complicated on-line and batch processing;
- Frequent interactions with the system are possible, creating the potential for human operation faults;
- Dependability of the IT service is affected by environmental changes (such as a sudden peak of traffic or frequent application updates) caused either directly or indirectly by social and economic activities.

IT services supporting such complicated systems are thought to be highly prone to accidents. We should aim to achieve higher dependability since these types of services are spreading widely throughout society.

In this thesis we discuss enterprise IT services with a focus on the following issues:

1. We survey legacy activities to prevent IT accidents by reviewing the literature and show that legacy models of understanding IT dependability have not been capable of meeting with threats of future IT accidents;
2. We identify functional elements that contribute to IT dependability and systematize these in a model;
3. We verify the qualitative and quantitative relationships between dependability elements and actual cases of IT defects that have been collected by the Information-technology Promotion Agency, Japan.

A number of approaches have succeeded in preventing IT accidents. For example, IT system dependability has been improved through the implementation of software development technologies. These include structured software testing and quality assurance technologies [6-1], higher-reliability hardware solutions such as popular clustering or RAID (Redundant Arrays of Inexpensive Disks) technologies, and continuous improvement of total system development projects such as the PMBOK for general projects and the CMMI or the *MIERUKA* for IT projects, which has been discussed in the Chapter 3. However, these technologies for improving system dependability are only applicable over a finite period of project development, that of IT implementation.

For during the operation phase after the launch of developed systems, there are the ITIL and ISO20000 [6-2]. These include best practices for IT service management and operation and incorporate measures to reduce human operation faults. They assume that necessary functions are developed by the IT development projects and that engineers of service management and operation use these functions as they are. Thus, even when extra functions in a broader sense (including human operations) are needed in IT services where higher dependability is required, we cannot find in the ITIL and the ISO20000, any model to define the functions' scope nor any guideline to assign responsibility to determine whether the functions should be developed or not.

Consequently, they seem to expect individual companies to have some suitable model and field engineers in the company to judge whether extra functions should be realized or not.

However, one hesitates to say that we are safe given the number of IT accidents broadcast by the Japanese news media (Figure 1-2).

We first surveyed the viewpoints of news media firms. According to a summary of 94 recent IT accidents [1-28] that were covered by the Japanese news media, 49 cases were due to product faults (i.e., reliability problems in a narrow sense including software bugs), 17 cases were due to human errors, and the causes of 28 cases were not specified. Thus, of the 66 cases whose causes were specified, approximately 70% were thought to be due to problems with product quality. This type of news continues to be broadcast because of recognition by the news media firms that there is no way to improve dependability except by improving software quality. However, Japan has been reported to have fewer potential bugs in its finished software than other major software producing countries such as India, European countries, and the United States [6-3]. Thus, we have doubts about whether this single approach can substantially improve the dependability of IT services associated with social and economic infrastructure.

Approximately 30% of covered IT accidents were thought to be due to human errors. However, since a recent evaluation said that the field operation departments of Japanese IT service operations wield a relatively significant amount of power [6-4], there seems to be minimal room to improve dependability in this area.

Based on the above discussions, we think that the keys to further improvement of IT dependability lie in the fact that few models have been implemented with a focus on dependability and there has been a lack of clarity in assigning responsibility for developing functional elements involved in each model. That is, we recognized that it is necessary to identify a model which clarifies assignment of responsibility on the assumption that IT accidents actually happen, since there is a high possibility of accidents in complicated IT services supporting social and economic infrastructure.

Upon the above recognition, we next investigated how social organizations understand the overall shape of the dependability in real terms.

We first proceeded to survey public associations of governmental organizations related to IT. The International Standardization Organization [6-5] and Japan Industrial Standard [6-6] define the external quality of software using six categories, including functionality and performance, but have not considered the control of faults, including bugs, to be a systematic category. The METI [6-7] first introduced the category of controlling faults when they expanded the six categories to 11 categories in focusing on non-functional requirements mainly for enterprise IT services. Furthermore, the category was broken down to two sub-categories, preventing occurrence of faults and preventing the spread of negative effects caused by faults. Despite these steps, the following can be observed:

- Most discussions have focused on preventing the occurrence of faults, with fewer concentrating on mitigating faults' negative outcomes. Moreover, there is no discussion on the importance of countermeasures to prevent the spread of negative effects caused by faults.
- Several checklists are intended to preventing the spread of negative effects caused by faults. However, the checklist items are described at an abstract level, for instance checking for the presence of countermeasures to initial

faults after the launch of an IT service. There is neither a systematic explanation of the expansion process by which an initial fault occurrence results in concrete negative outcomes nor suggestions to develop specific countermeasures to cope with the adverse events.

Next, companies that provide actual IT services generally assign causes to IT defects or accidents using categories such as developed application bugs, system infrastructure problems, or maintenance or operation issues. Each individual category corresponds to an accounting department within the company. Consequently, IT dependability is effectively the sum total of each department's efforts to improve its own individual quality measures. However, it is quite unlikely that the overall structure of departmental organizations is derived from a systematic attempt to anatomize the elements that yield optimal IT dependability and then represent these in organizational form. Rather, it seems that these companies have a model of dependability that consists of elements corresponding to individual departments. However, given the number of IT accidents illustrated in Figure 1-2, there are doubts about the adequacy of such a model.

6.2 Systematizing Elements of Dependability

Economically speaking, IT companies benefit most if elements of dependability correspond to existing organizational departments that are hypothetically derived from the point of view of economical rationalism. However, although the idea of this dependability model is reasonable for an IT service provider, it is difficult to say whether third parties can objectively understand the appropriateness of the model.

The reason for this is that the causes of nearly half of the 94 IT accidents mentioned earlier were either not clear or were treated as only human operation faults. Doubt remains as to whether the best way of improving dependability is to divide responsibility among existing departments in the organization.

To deal with this doubt we use modeling to clarify the structure of dependability.

As mentioned before, IT services that support social and economic infrastructure are complicated systems. In order to allow us to model the entire configuration of the complicated systems, we first defined the following three elements to describe the phenomena that occur before the outbreak of IT accidents by using fault-tolerant model [6-8]:

- ◆ Faults: These are root causes that trigger successive events before IT accidents occur. They include, 1) product faults such as software bugs and hardware defects, 2) human operation faults, and 3) environmental changes such as a sudden increase in network traffic or data processing load;
- ◆ Service errors: This is a possible status event, which may causes future IT accidents or exacerbate these accidents' negative effects (the service error corresponds to an error in the fault tolerant model);
- ◆ Service failures: These are events that negatively influence social and economic activities, for instance terminations of service for a long period of time (IT accidents in the worst case).

By using these elements, we can formulate fault-tolerant functions promoting higher dependability as shown in Figure 6-1. We define the functions in IT services as follows:

- ■ Safety operation functions: Organizational structures that mitigate actual damage to social and economic activities by responding to service failures, even when faults cannot be fixed.

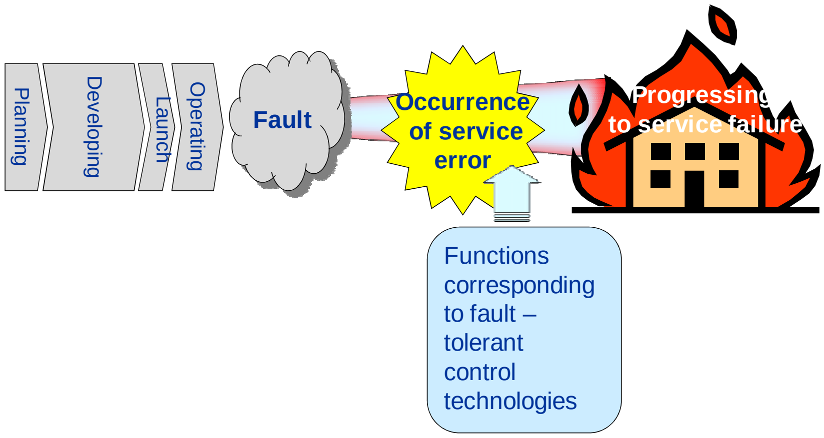


Figure 6- 1 Legacy fault-tolerant model when applied to existing IT service as it is

Component errors in fault-tolerant devices can be identified relatively more easily by extracting possible production fault cases from design specifications of the devices. However, in IT services related to social and economical infrastructure, there can be a wider range of fault sources, which include not only production faults of all software and hardware devices but also environmental changes and human operation faults by system operation and maintenance engineers. Thus, since the more simple identification methods are not applicable to IT services as they are, we need the following additional functions to cope with service errors caused by a broader range of fault sources.

- ■ Additional safety functions: Functions to identify service errors and decide mechanisms executed in safety operation functions to prevent faults from developing into service failures, or reducing the negative influence of the service failures, even when service errors occur.

The following additional information is necessary as the fourth element to execute such identification and decision in the functions.

- ◆ Early warning sign (EWS): Alert providing notification that service errors caused by faults could progress to service failures.

We call a set of the additional safety functions and the safety operation functions an on-demand safety system.

IT service experts must consider the final scope of the first type of function based on a balance between additional investment and expected total loss, including degradation of social reputation and opportunity loss, since additional development costs other than those necessary for system development are required. Since these functions require decision making regarding contingency plans, the final responsibility for them should rest on IT owners or management executives rather than on field operation and maintenance departments.

In contrast, responsibility for the second type of function is assigned to the field organizations that implement them.

Based on the above discussion, we systematize a bird's-eye view of dependability as shown in Figure 6-2 by considering the legacy system's dependability, whose responsibility should rest on development departments. According to this viewpoint, overall dependability is composed of the legacy system's dependability, the additional safety functions and the safety operation functions. Since we categorize the tree elements according to the relevant responsibilities, we call this model a manageable dependability model.

A Legacy research on improving dependability of enterprise IT services has focused on preventing faults through improving software quality and fault tolerant technology [6-9] or activities to reduce human operation faults. In contrast, our original approach is to introduce concepts of fault tolerance to the enterprise IT service by taking into account not only service errors but also EWSs.

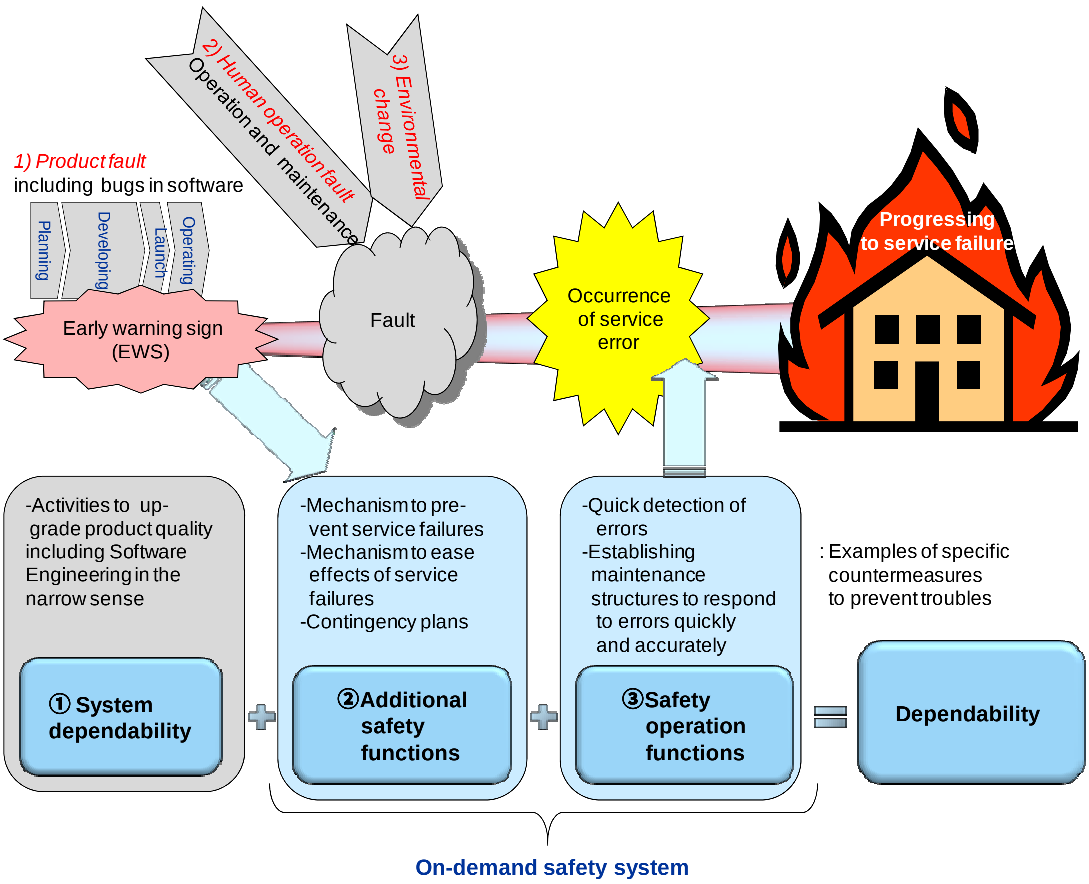


Figure 6- 2 Systematized model of dependability for IT service (proposed model)

The outcome of legacy research has included improving software quality to prevent production faults and developing fault-tolerant technologies to increase device dependability. These approaches have been implemented in IT systems facilities as freeze logic and have played a role in system dependability as illustrated in Figure 6-2.

Problems occur if the additional safety functions and the safety operation functions in Figure 6-2 always implement the same freeze logic as the system dependability processes, since the additional safety functions have to be developed by considering the following features:

- The final functions to be implemented are decided upon by IT owners or management after limiting and prioritizing candidate functions through a process of obtaining expected probabilities and impacts of each of them;
- Commitment to a function is not a permanent decision. Flexibility is important since the dependability of IT services is contingent on environmental changes. Thus, implementation methods are required to avoid a loss of investment and to realize the maximum scope of functions under a limited budget.

It is probable, then, that the flexibility to change the scope of countermeasures with the aim of higher dependability will lead to a degradation and consequent reduction in the overall scope of available countermeasures if the additional safety functions or the safety operation functions are implemented in facilities that utilize freeze logic.

Therefore, most of the additional safety functions and safety operation functions are thought to lack freeze logic, with a few exceptions, for instance cheap software tools. Implementation of these functions is supposed to follow an approach that requires no extra cost beyond keeping structures of the safety operation functioning normally except during emergencies, during which times costs can be potentially very high. In this sense, we call the combination of additional safety functions and safety operation functions an “on-demand safety system”.

6.3 Verification of the Model Based on Actual Cases

We next verify whether or not actual IT accidents can be explained using the dependability model illustrated in Figure 6-2. Specifically, we determine whether existence or absence of the functions in the on-demand safety system affects the dependability of IT services by using actual IT accidents documented at the IPA.

6.3.1 Qualitative Verification

Case 1

In this case, the response of an on-line service was delayed after the service was started, although a quick and stable response had been observed in the service before the accident. The accident was caused by a batch processing delay in which the process remained active even after the scheduled on-line service start. The delay had been caused by the misexecution of an operator command, which consumed significant server resources while the batch was running.

In this case the fault was the inappropriate running of the command, the service error was batch-processing delay and the service failure was the slow response of the on-line service. An EWS could have prevented this case if by some means such as IT service evaluations the problem had been pointed out before the accident occurred.

The dependability of the service could be improved further if either one of the following functions was implemented:

- An automatic mechanism that starts up on-line applications and gives a higher executing priority to these applications when batch processing is still in progress at the scheduled on-line start time, on the assumption that such service error may happen in reality (additional safety function);
- An organizational structure that, when the automatic mechanism cannot be applicable to the service, more rapidly detects the service error (the batch-processing delay), starts up on-line applications punctually, and gives higher executing priority to the applications without fail, (safety operation function).

Since the service error may be caused not only by human operation errors or bugs in batch-processing programs but also by environmental changes such as a sudden increase in data-processing load, it can be concluded that the service lacks the necessary on-demand safety system.

Case 2

In this case, clerks working at computer terminals in shops of customer divisions found that IT services were suddenly unresponsive, although these services were stable and responsive before the accident. Many of the terminals had to be shut down for days since it took a long time to recover service. The reasons for this delay were as follows:

1) Too much time was spent identifying the cause of the abnormal phenomenon.

In this system, a network facility was composed of a dozen high-end network elements that were duplicated to achieve higher system dependability. However, the IT system division had not implemented a mechanism that would detect the abnormal performance of any given network element, since the devices had been very popular and selling well worldwide and development costs had exceeded the budget allowed. Furthermore, the organizational structure necessary to respond to such a case did not exist.

2) Too much time was spent recovering service after detection of the cause.

The cause of the abnormal phenomenon was a bug in the control software whose effects were triggered by changes in telecommunication traffic, i.e., an environmental change. However, even after the cause was detected, there were many ways to avoid the problem, though every option had potential adverse effects. Further complicating the matter was that the bug in the commercial system could not be reproduced in the testing system, while poor cooperation between the systems division and the customer divisions complicated the development of methods to avoid a solution’s potential side effects. Thus, methods of trial-and-error were employed so as to avoid the bug’s negative influences during the IT service’s on-line service time. This extended the number of days necessary to eventually recover full service.

The fault in this case was caused by an unknown bug in the software product in the network element device, the service error was the delay in identifying the cause of the fault and then recovering service, and the service failure was the extended unavailability of business processes at a large number of terminals. If the risk of this case were somehow pointed out before the IT accident, the alert of the risk would be defined as the EWS.

The dependability of the service could be improved by reducing the duration of terminal downtime through implementation of the following functions:

- Introduction of a mechanism to quickly alert a human operator of the abnormal performance of a network element device’s input and output response (additional safety function) and an organizational structure to respond quickly to the abnormal performance (safety operation function);

- Commitment to testing bug reproduction procedures and to verifying side effects of fixing the bug in the commercial system supported by corporate customer divisions after the planned time of window closure, on the assumption that such bugs may actually appear in a complicated system (additional safety function to ease negative influences of service failures), and an organizational structure to execute testing in the commercial system in cooperation with the customer divisions (safety operation function);
- Establishment of contingency plans to continue minimum business processes in the customer divisions even when IT systems are not available (additional safety function) and an organizational structure to execute these plans (safety operation function).

We would encourage management or owners of IT services that support social and economical infrastructure to determine the proper amount of effort to devote to preventing terminations of corporate processes by judging specifically the degree to which they should implement such on-demand safety systems as described in Case 2.

Case 3

If symptoms of the service error are unobservable, there is no way to avoid the negative influences of subsequent service failures, except by eliminating the corresponding causes (faults) of the IT accidents. For example, in this case, test mail was inadvertently sent to actual users because some addresses registered in the test database were equivalent to those of actual users. Engineers failed to detect the problem.

6.3.2 Quantitative Verification

It is difficult to verify the effectiveness of the proposed model quantitatively, since the broadcasted information of the 94 IT accidents mentioned above contain insufficient information to do so. It was impossible to obtain more detailed information about these cases since this was prohibited by corporate security. We therefore verified effectiveness of the model by collecting as much actual field information on the cases as possible using the approach mentioned below.

1) Method for Case Specification

We obtained information regarding IT accidents from a sectional meeting named Project *MIERUKA* held at the IPA, where strict privacy standards are maintained. The meeting members have 20 to 40 years of experience in developing and maintaining mission critical IT systems for IT vendors or IT users in Japan.

Members recorded information not just about the basic events that transpired during IT accidents but also about outcomes of the events and the countermeasures taken against them. Forty two cases were summarized.

2) Method for Case Analysis

First, causes of IT accidents were classified into three categories (product fault, human operation fault and environmental change), which are the same as those mentioned in the early section.

We shared the definition of the system described in Figure 6-2 and used this to further differentiate whether or not by introducing the on-demand safety system it would have been possible to prevent service failures and ease their negative effects.

Moreover, the following procedures were used to avoid biasing the investigation and analysis.

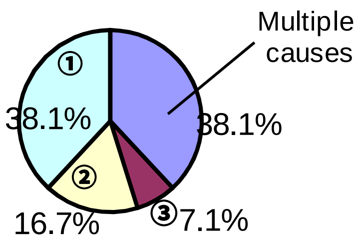
- Members in the sectional meeting of IPA, who were from different companies and offered the cases, performed analysis and evaluation independently without any interference from each other.
- The analysis was summarized after all of the results were reviewed and corrected in the final sectional meeting.

3) Results of analysis

Figure 6-3 shows the results of the analysis of accident causes. Among the 42 cases, approximately 74% were due to product faults, which is nearly the same rate as that seen in the 94 IT accidents mentioned above. This confirmed that activities related to upgrading product quality, which have been focused on thus far, are important.

We also determined that the ratio of cases where it was possible to have prevented service failures or ease their negative effects if the on-demand safety system had been implemented was 59.5%, as shown in Figure 6-4.

Causes of IT accidents			
Single cause			Multiple causes
① Production faults	② Environmental changes	③ Human operation faults	
16 cases	3 cases	7 cases	16 cases



①+② : 4.8%(2 cases)
①+③ : 21.4%(9 cases)
②+③ : 2.4%(1 case)
①+②+③: 9.5%(4 cases)

73.9% of IT accidents related to production faults(①).

Figure 6- 3 Classification of causes of 42 actual IT accidents

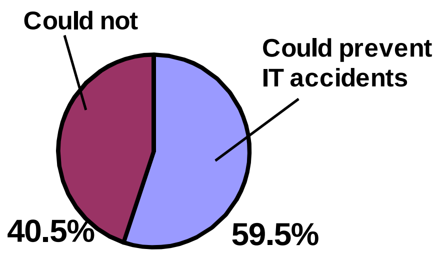
	Total	On-demmand saftey system	
		could not prevent IT accidents	could prevent them
No. of cases	42	17	25
Rate(%)	100.0%		

Figure 6- 4 Quantitative verification based on actual cases

6.4 Consideration

Several lessons can be learned from the fact that service failures or their negative effects could have been prevented or eased in approximately 60% of the cases by implementing additional safety functions and safety operation functions.

1) The proposed model, which explicitly introduces additional safety functions and safety operation functions that are distinct from functions utilized in traditional system dependability, is thought to be effective for improving dependability of IT services.

2) Although the additional safety functions and safety operation functions may have been implemented as a result of voluntary efforts of individual field engineers, we are not aware of any systematic and organizational scheme to develop them. We believe that dependability of IT services will be improved by organizational efforts to develop and share among IT services tools to implement the additional safety functions and safety operation functions explicitly demonstrated in the proposed model. Further benefit will be derived from introducing approaches to obtaining feedback from lessons learned while applying these tools to field services and from continually enhancing the tools over the long-term.

6.5 How to Move Forward

It is difficult to say that the proposed model is clear enough for field persons to practice improving IT dependability in actual.

In order to move forward this research to applying to actual works in the fields, it is necessary to promote introducing the model by coping with the following questions.

1) View of developing

It is necessary to show what should be added or changed to the legacy IT service development. It is also required to show overall view of developing the IT dependability including legacy development style.

2) Means

It is necessary to show how to improve the IT dependability as tools for practicing improving the IT dependability.

3) Thread to improvement in the long term

It is also necessary to show the thread to improve the IT dependability in the long term by using tools of 2) under the new development style mentioned in 1).

In order to cope with these questions from a viewpoint of practices, actual ways for developing IT services and improving the IT dependability are suggested in Attachment 6-1.

6.6 Conclusion

We clarified the functional elements (the additional safety functions and the safety operation functions derived from a point of view of manageability) of the dependability of IT services underlying social and economic infrastructure and systematized the overall structure of this dependability.

We clarified that service failures or their negative effects could have been prevented or eased in approximately 60% of the cases of the IPA by implementing additional safety functions and safety operation functions.

We are considering specific approaches to developing the functions as well as the tools [1-29] to implement them in actual field services as shown in Attachment 6-1.

Attachment 6-1

Example of Implementing On-demand Safety System based on the Proposed Model

In actual practice, additional safety functions and safety operation functions take on various forms such as operation and maintenance documents and organizational structures including not only operation and maintenance engineers but also persons in end-user divisions or contingency plans decided on by management. It is therefore difficult to use existing methods that have been used to develop general IT systems, and instead new methods are required for highly dependable IT services that support social and economic infrastructure.

It should be noted that additional safety functions and safety operation functions require expanding the process for developing an on-demand safety system beyond the usual system development processes illustrated in Figure 6-5.

Improvement of the dependability of IT services associated with social and economic infrastructure has depended more on the skills of individual engineers working in system development departments or operation and maintenance divisions rather than enterprise organizations or management, as there have been no "managed" models and fewer methods for the higher dependability than those for system development. Thus, there is no assurance that these functions are implemented.

On the contrary, it become possible to normally implement the on-demand safety system by using the following tools under organizational orders, if the dependability systematized in Figure 6-2 is commonly recognized.

1) Tools utilized mainly during the planning or development phase

- A bird's-eye view of causal relations;

This is a diagram to extract functions of the on-demand safety system by understanding an overview of causal chains of problematic events, one of whose example is shown in Figure 6-6.

- A summary of service failure cases

Each case includes concise records of an actual failure event and is composed of facts that include immediate countermeasure taken and lessons learned. An example is shown in Figure 6-7.

These are used to support practical decision making regarding the implementation scope, since these tools can be used as EWSs to identify service errors and extract necessary functions.

2) Tools used after function development;

- Checklists

These are used for verifying whether IT services can be launched are based on clarifying whether developed functions are sufficient or not (an example is shown in Figure 6-8).

Moreover, even after IT accidents occur and are fixed in operation phase, improvement of the dependability of IT services associated has depended more on the skills of individual engineers working in system development departments or operation and maintenance divisions rather than enterprise organizations or management, as there have been no systematized models and fewer methods for the higher dependability than those for system development. Thus, it has been difficult to identify clearly what is improved. On the other hand, as illustrated in Figure 6-9, it becomes easier to manage that outcomes of improving the IT dependability are actually obtained, since outcomes of feedback from the IT accidents are much more visualized by sharing the above tools. It is also possible to improve the total IT services associated with social and economic infrastructure in the long term, by continuing practicing such improvement cycles.

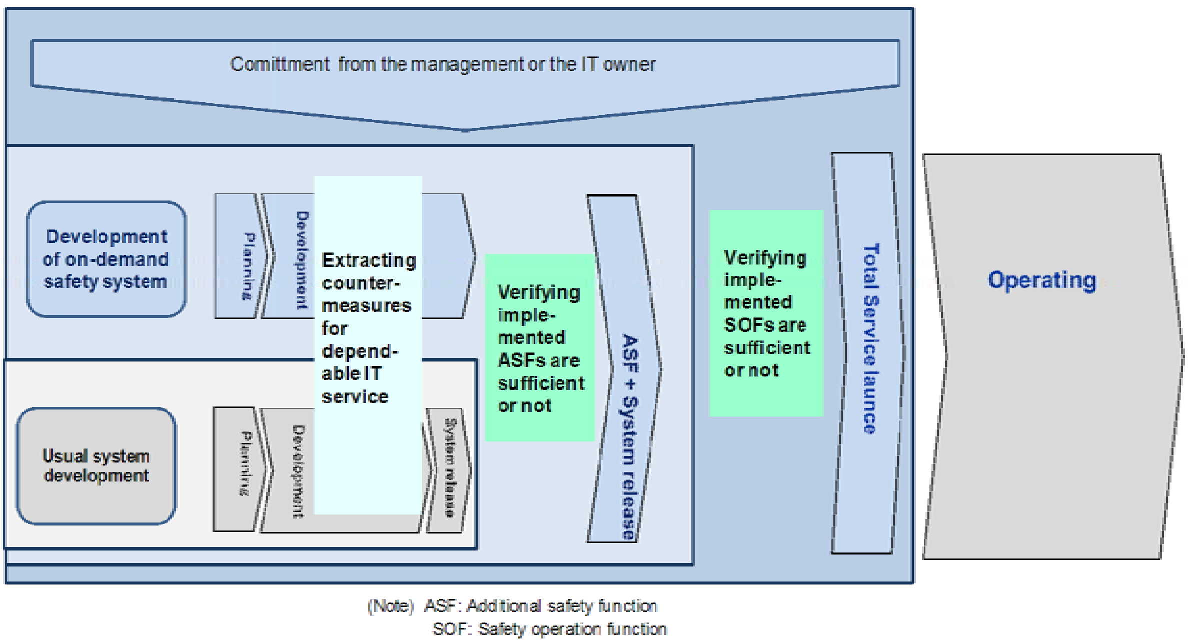


Figure 6- 5 Developing style for implementing additional safety functions and safety operation functions

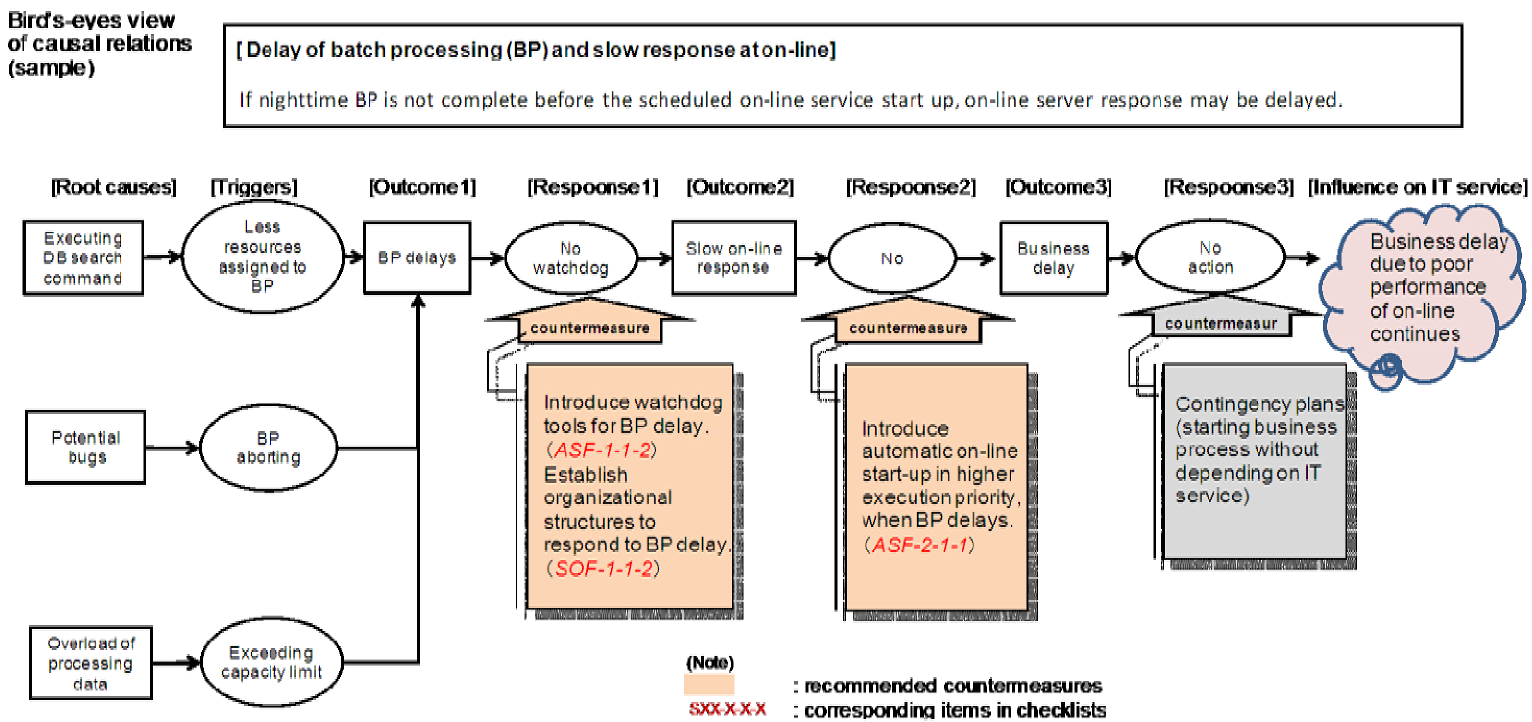


Figure 6-6 Bird's-eyes view of causal relations (a sample of batch processing)

Case No..23 ***Troubles after launch of a mobile internet accsess service***

Abstract Development of a new system function to enhance mobile internet access had been successfully completed. Function quality was verified before launch and no problems were found. However, after the launch was approved, servers become overloaded.

Cause The function was provided to all mobile users without any restriction. Servers became overloaded due to unexpected peak traffic.

Temporal measure Efforts to reduce call using workarounds (announcement to all mobile users, etc.)

Permanent measure Enhancing capacity by increasing number of server facilities.

Lessons learned
When the release of the new internet access function is verified, confirm both the quality of the function and also the presence of a mechanism (additional safety function) or organizational structure to cope with sudden peak traffic, before the approval of function launch.

Figure 6- 7 Service failure case (a sample)

Category	Check items	ID	Specific contents of verification	Causal relations	Failure cases
Early detection of errors	Functions to detect release error of software update and procedures to put system back				
	Functions to detect and warning delay of batch processing in night	*ASF 1-1-2*		Diagram #1	Case #1
	:				
Error recovery procedures	Preparing procedures to keep on-line service stable when batch processing delays	*ASF 2-1-1*		Diagram #1	Case #2
	Preparing procedures to recover system quickly after detection of release error				⋮
	Preparing procedures to execute the rest of batch processing, which is postponed due to priority policy of on-line first				
Commitment by the management or IT service owner	Are organizating and maintaining structures of safety operation functions approved including periodical practice training?				

- Are proper time limits decided so that delay of batch processing may not cause bad influences to business process by degrad of on-line performance?
- Is a detection function for the delay implemented?
- Is a warning function also implemented? (It is also recommended to change alerting message by emergency priority such as “warning” or “error”)

- Are procedures to start up on-line and give higher priority to on-line prepared, when batch processing delays?
- Particularly, are there procedures to identify which jobs in the batch can be postponed their execution and which jobs can not?

(Note)
ID : Unique number of check item
Causal relations: Corresponding number of bird's-eye view diagram of causal relations
Failure cases : Corresponding number in summary of failure service cases

Figure 6- 8 Check list (a sample of additional safety function)

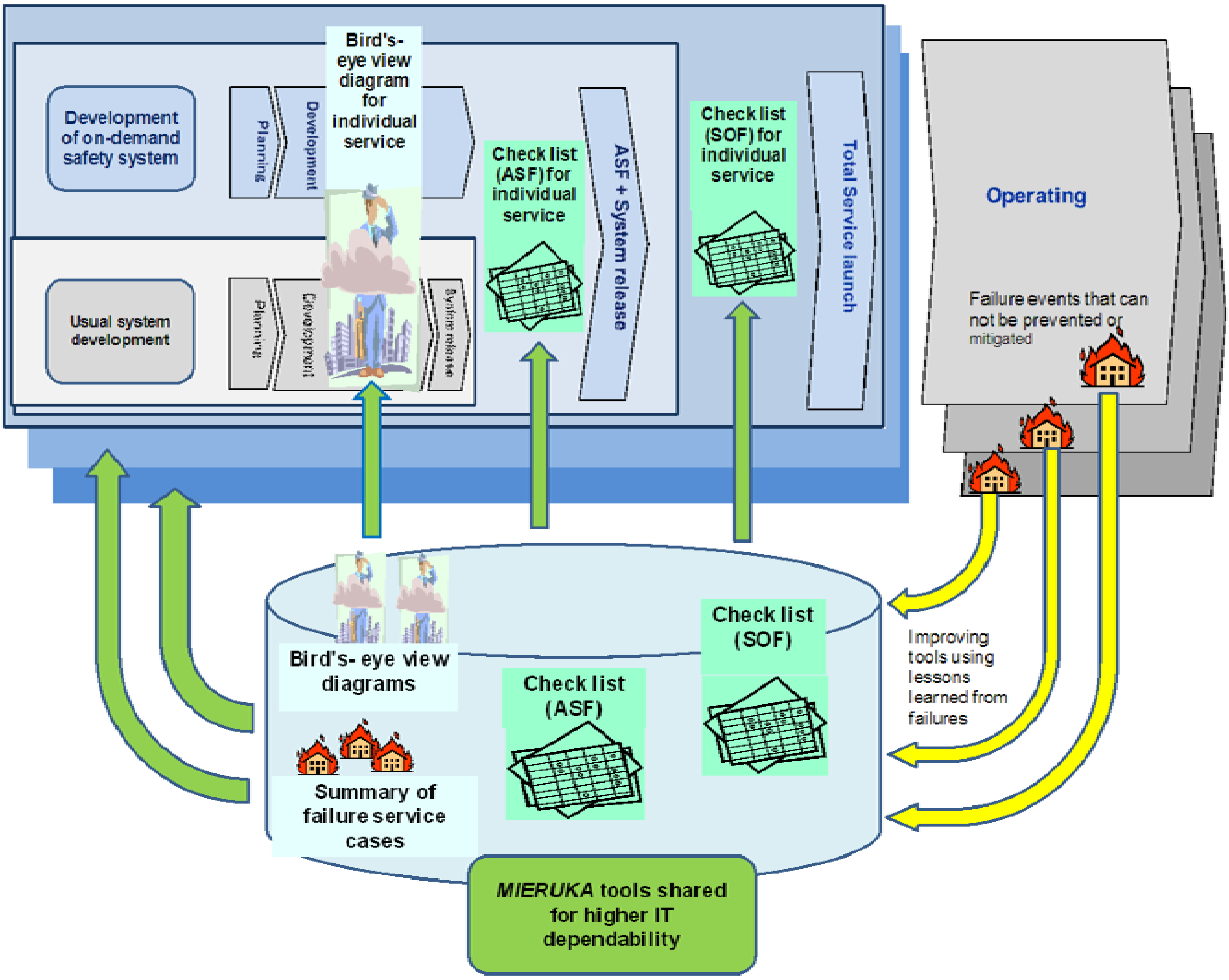


Figure 6- 9 Continuous improvement of dependability by introducing common tools

Chapter 7

Conclusion of the Thesis

We would like to conclude the thesis by summarizing major points concerning the four research subjects mentioned earlier in the Chapter 2 and also by presenting future studies.

7.1 Summary

Research subject 1)

As the IT applications spread to the social and economic activities more, the frequent occurrence of the IT problem projects may be a source of our larger threats. Thus, in the Chapter 3, we first thought it a basic subject that the IT specific project management knowledge for prime contractors depends on the tacit knowledge of individual PM and it was difficult to say that the knowledge is sufficiently generalized and systematized.

To cope with the subject, we systematized the tacit knowledge of PMs who had never failed to achieve goals of the QCD in general IT projects as prime contractors, by categorizing the knowledge into three approaches, namely the qualitative approach, the quantitative approach and the integrated approach.

. We also let the method to be easily introduced and used by PMs in general IT projects, by formalizing the knowledge as the tools including the Bird's-eye view, the Check sheet, the List of measured analysis data and the Table of categorized item. By applying the tools to actual IT projects, we confirmed the effectiveness of introducing the method, including preventing cost overruns.

Moreover, the research outcome above is expected to contribute to raising the bottom level of PMs higher in the IT developing firm, by having been practicing seminars of IPA/SEC in Japan.

Research subject 2)

It had not been verified that legacy researches focusing only on PMs are not sufficient for preventing the occurrence of problem projects. This has been an obstacle to promote researches to prevent problem projects by stakeholders other than PMs. Thus, in the Chapter 4, we discussed objectively about how the stakeholders including customers, senior managers and sales persons are related to the problem projects, by analyzing actual cases. From the outcomes, which shows that these stakeholders are related to more than 70% of the SPP cases, the following conclusions were obtained regarding SPPs:

- There are a significant number of SPPs that cannot be prevented by the marginal capacity of the PM.
- Because SPPs include problems that relate to the overall business activities of the SI company or problems beyond the PM’s control, it is important for the planning stakeholders, including the senior manager and the customer, to take an organizational approach.

These outcomes eliminate the obstacle to promote researches to prevent problem projects by stakeholders other than PMs.

Moreover, in order to practice studies effectively on reducing the number of SPPs in the future, we recommended practical countermeasures for the stakeholders including the management executives.

Research subject 3)

Among problem projects in the IT firm, the SPPs, which have magnificent influences to the social and economic activities, occur due to multiple causes both inside projects and outside projects. The SPPs are apt to be hidden since they have shapes of complicated and long causal chains of multiple causes and it has been often too late when countermeasures begin to be practiced at the time when they come to light. It has been difficult to identify such major risks of the SPPs, even when we use the risk management in the PMBOK or the method for the general project management mentioned in the Chapter 3.

Thus, in the Chapter 5, we proposed a model to describe the growing process of major risks, which cause the SPPs, by using cyclic causal models. We next analyzed the relationships between the model and the actual SPP cases and clarified that more than 80% of actual SPP events occurring in cases of trouble projects summarized by the IPA had relationships with the causal model of SPPs. Based on the outcome, we derived the method to identify the major risks earlier than legacy methods in the IT firm.

Research subject 4)

Although we have increasing threat of IT accidents which may cause significant negative influences to the social and economic activities in the future, the management responsibility of the total dependability of the IT services in the user company has not been clear. Thus, it has been required for us to develop a manageable model to clarify the management responsibility of the total dependability of the IT services in the organization.

Thus, in the Chapter 6, we clarified the functional elements (the additional safety functions and the safety operation functions derived from a point of view of manageability) of the dependability of IT services underlying the social and economic infrastructure and systematized the overall structure of this dependability. We also clarified that approximately 60% of the actual IT accidents can be potentially avoided by introducing the model, after evaluating the model from a viewpoint of improving the dependability. Furthermore, we suggested practical examples of methods including tools to implement the model, for the progress of the future researches.

As we discussed earlier in the Chapter 1, it has been difficult to say that all of the industry and the academia are struggling to research and develop countermeasures to cope with the problem of the project management in the IT specific knowledge area. However, if they keep thinking so, problem projects may be apt to occur in the IT firm and may become a threat to cause various bad influences to the social and economic activities also in the long terms as mentioned before. It has been very regrettable that we cannot expect reducing the amount of such threat if we still kept depending on the KKD.

Thus, the author dared to focus on the IT specific knowledge in this thesis. Compared with the traditional KKD method and legacy researches which have been mainly focusing on PMs, the author, as a chairman of the of the IPA working group, summarized tacit knowledge of professionals, which include cases and has been implicitly stored in individual person or individual company, by acquiring strong supports of professional members of IT companies in the working group, and he also practiced researches by not only targeting to PMs but also expanding the scope to stakeholders excluding the PMs. Thus, various management knowledge of the expanded scope were generalized or systematized much better than before, by using objective evidences derived from case analysis, and consequently the above four outcomes were obtained.

The author has been learnt much from his long experiences for more than thirty years, thanks to the IT firm. The author would be happy if the research outcomes in the thesis could be the least he can do to show his gratitude to the IT firm by easing the threat mentioned above.

7.2 Future Studies

As discussed in the earlier chapter, it is important for us to move forward the researches to a sound common field of researches, which both of the industry and the academia recognize their importance. Because it is thought that this prevents the occurrence of problem projects in the IT firm with more certainty, and consequently this strengthens the foundation to meet with the further requirements for the IT to spread to the social and economic activities.

As for the four research subjects mentioned in the Chapter 2, the solutions were obtained as summarized in the previous section. However, this thesis just shows partial solutions for strengthening the foundation to meet with the further requirements for the IT to spread to the social and economic activities. Therefore, additional future activities are required to wipe out problem projects with more certainty, by using various human resources in the long term.

Specifically, there are the following subjects remain to be researched. It is also explained below how to move forward as for the subjects.

1) Standardization of an extension for IT specific management knowledge

As explained in the Chapter 1, although extensions to the PMBOK for the application specific knowledge of some firms including the construction can already be seen, we cannot observe an extension for the IT specific knowledge. The extended version for the IT firm is required for acquiring much more human resources from the world in cases such as offshore developments in the future.

Thus, considering the outcomes for the research subject 1) and the popular status of the outcomes in Japan, which have been explained in the Chapter 3, developing an extension for the IT specific knowledge using the *MIERUKA* method becomes to be our next research subject.

Specifically, it is thought that we should achieve the following milestones.

- Popularizing the *MIERUKA* method by applying the method to offshore IT projects in Asian countries,
- Popularizing the method in the other countries including USA and European countries after modifying the method to meet with international requirements by reflecting the outcomes of the applications to projects.
- Proposing the method as a standard by refining the method to meet with required format like the PMBOK..

2) Standardization of management practiced by stakeholders

Although the necessity of countermeasures practiced by the stakeholders were clarified and practical countermeasures for the planning stakeholders as well as the management executives are recommended in the Chapter 4, it is not sufficient to perfectly prevent SPPs in the future.

It is necessary for us to summarize much more practices for stakeholders by continuing case analysis regarding SPPs of IT in the worldwide, and move forward to future research to establish standards regarding stakeholders including the planning stakeholders and the management executives to prevent SPPs with more certainty.

3) Improving the method to identify major risks

Based on the research outcomes mentioned in the Chapter 5, it is necessary for us to move forward the future research as follows.

- We try to apply our method to as many projects as possible by introducing the method at domestic and international conferences particularly for project managers, senior managers and customers. We also obtain the SPP occurrence rate (the number of SPP cases divided by all the cases) when the method is applied and the SPP occurrence rate when it is not applied, and clarify the difference.
- The proposed method is expected to identify major risks of about 81% SPP cases. However, there still remain cases where it cannot identify major risks (about 19% SPP cases are expected not to be identified). For such unidentified major risks, we intend to improve the precision of the model by using tools like the Cognitive Mapping to acquire findings to improve the accuracy of the success rate of identifying the major risks.
- Cumulating such improvements, we move forward to propose standards for identifying major risks to prevent the SPPs in the future.

4) Implementing the IT dependability model and organizing structures

Based on the outcomes mentioned in the Chapter 6, it is necessary for us to consider specific approaches to developing the functions required as well as enhancing the tools to implement them in actual IT services.

However, difficult issues still remain before improvement in dependability can be realized in practice. It is also necessary for us to verify whether the tools suggested in the report can be used in the actual IT departments of companies that offer social and economic infrastructure services. It is also necessary for us to practice verification by developing the tools, publishing the outcomes, and introducing the technologies to the actual systems. However, as far as the author knows, companies currently do not contain divisions that are primarily responsible for the proposed functions (additional safety and safety operation). Even when there are divisions charged with putting the functions into practice, we have had difficulty identifying who exactly is responsible since the role of developing the functions is distributed among many divisions such as an IT development division, operation planning division or IT operation and maintenance division. It is also necessary for us to execute the verification of our technologies by addressing the relevant issues not only from the engineering standpoint, but also from that of management.

As you can understand from the above explanation, it is difficult to move the researches of the IT specific knowledge forward, without an environment where the researches can be continued for a long time. It is regrettable that we can seldom find such ideal occupational environment in both of the IT industry and the IT academia at present.

The author has his gratitude for having been engaging in the IT related jobs for a long time and having been learnt a lot from the firm of the IT, which is expected to evolve to a much more important infrastructure in the future. It is sad if young students become to keep away from applying their jobs for the IT firm, because recent news of the Japanese news media call the jobs of the IT firm like "13K". In order to avoid such situation, the author aims personally to continue the researches as long as he can, although the researches may be limited to the volunteer base. The author also aims to urge the related organizations to realize the ideal research environment as far as he can.

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Appendix

Research Achievements

Journals

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2 Hiroshi Ohtaka and Yoshiaki Fukazawa,
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2 Hiroshi Ohtaka, Koichiro Oshika, Masashi Gotou and Yoshiaki Fukazawa,
"Study on Improvement of Dependability of IT Services for Social and Economic Infrastructures", Asia Pacific Industrial Engineering & Management Systems Conference (APIEMS), Kitakyusyu, Japan,
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3 Yoshiki Mitani, Hiroshi Ohtaka, Noboru Higuchi and Ken-ichi Matsumoto,
"A Proposal for an Integrated Measurement and Feedback Environment for Software Projects Based on the Empirical Study of Three Measurement Domains", International Workshop in Software Measurement and International Conference on Software Process and Product Measurement (IWSM/Mensura), Amsterdam, Netherlands,
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4 Hiroshi Ohtaka, Yoshiki Mitani and Yoshiaki Fukazawa,
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5 Yoshiki Mitani, Hiroshi Ohtaka, Ryozo Nagaoka, Hiroyuki Yoshikawa, Noboru Higuchi and Seishiro Tsuruho,
"A Proposal for Integration of In-process Project Visualization and Keeping Post-process Traceability: '*MIERUKA*' Method and 'Software Tag' Framework", Asia-Pacific Software Engineering Conference/ Workshop on Accountability and Traceability in Global Software Engineering (APSEC/ ATGSE), Beijing, China,
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10 Hiroshi Ohtaka,
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Award

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