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Risks associated with the development process of in-house information system projects

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Abstract:
To provide a risk management perspective for managers responsible for in-house project development, we investigated how the risks associated with an in-house information system (IS) project evolve during the software development process. We conducted interviews and content analysis to examine the risks that affect project delivery quality. Three companies participated in this research. The results of this study indicate that risks related to organizational structure persist throughout the software development process. Content analysis indicated that in the conducted interviews, sentences regarding task- and actor-related risks characterized the first two phases of this process, and sentences regarding technology-related risks characterized the last two (third and fourth) phases. The results also suggest that different types of risks exert pressure on in-house project teams to reassess the weaknesses and resource allocation in a project and the possible solutions to any potential problems. This research explains risk dynamics throughout the life cycle of in-house IS development. Moreover, the findings of this study can help project managers identify the risks associated with the project development process that directly affect the project results.

Keywords:
risk; in-house IS project; project development process.

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1. Introduction

In-house projects are projects developed within a company, and companies frequently develop such projects [1]-[5]. In-house projects are a competitive asset because they involve developing services, business knowledge, and governance procedures that fit the organization [1]. Some researchers have identified the factors affecting whether companies choose to develop in-house projects or outsource projects. These factors include contract problems, problems related to power and politics, organizational structure, and business environment [3],[6]. Many studies have assessed the risks involved in the evaluation of the decision-making in an in-house project, including those related to cost, service quality, company strategies, or resource accessibility [7]-[9]. The primary concern related to in-house projects is the lack of product quality, and the factors affecting the product quality in an in-house project must be subjected to risk management in the project development process [5],[6],[9],[10]. Although a growing number of researchers have investigated the risks involved in decision-making related to in-house projects, limited attention has been focused on the risks in different phases of an in-house software development process.

Several studies [11]-[15] have suggested the existence of four types of project risks: those related to tasks, structures, actors, and technologies. Task-related risks include task ambiguity, task complexity, continual requirement changes, and wrong function design, all of which lead to an increase in cost caused by the requirement of additional or revised functions [11]-[15]. Inefficient communication, incentive mechanisms, or governance; poorly defined responsibilities; unrealistic schedules; and inappropriate workflow and coordination, are some structure-related risks [13]-[15]. Actor-related risks include low skills, poor attitudes, low experience, and low capability as well as ethical issues among project participants [12],[13]. Such risks entail an extra cost related to training or the extension of the project schedule. Finally, technology-related risks include technical complexity, unreliable components, untried technology, and system extendibility [11],[14],[15]. In in-house information system (IS) projects, skilled actors use flexible communication channels and powerful business domain knowledge to reduce risks related to the organization structure and actors. However, the creeping project scope or complexity of the integration between the new technology and legacy systems may increase the risks involved in these projects [2],[16]. Therefore, these projects might involve different risks than do those involving outsourcing. Thus, managers of in-house projects must identify task-, structure-, actor-, and technology-related risks that might lead to unrealistic expectations or underperformance.

The participants of an in-house project use their domain knowledge and social capital to reduce task-, actor-, and structure-related risks [2],[9]. This statement is valid under the premise that these participants are familiar with relevant business processes and have formed the informal or formal social relationships required to clarify what the relevant tasks involve and construct an effective communication system for the project [2],[8]. To face task-related risks, managers of in-house projects define appropriate boundaries for the project. They solve a variety of unforeseen problems related to the ambiguity of tasks because they understand the relevant business processes that must be adopted; they also address the structured, unstructured, or nonroutine problems that might be encountered in the project [2],[3],[17]. In an in-house project, smooth and effective communication structures play a critical role in the acquisition, distribution, exploration, and utilization of core knowledge or internal information. The manager of an in-house project must manage the risks of an ineffective coordination mechanism, an inappropriate job design, or actor turnover because in-house projects involve interwoven business processes [1],[6]. Furthermore, the manager must reduce or avoid the use of overly complex technologies to control technology-related risks. Incompatibility among legacy and new systems as well as poorly designed interfaces may increase technical complexity. Moreover, the manager might face a limited choice of methodologies and technologies [13], [18].

To achieve success, the manager of an IS project must be aware that different risk indicators must be emphasized in different project types [13],[15],[19]. Effective risk management enables the successful implementation of an Information Systems (IS) project [16]. The present study investigated the risks involved in in-house projects by analyzing four project phases: the planning, analysis, design, and implementation phases. Social technology theory was adopted to identify the risks involved in in-house IS project development. Effective risk identification can guide project practitioners to focus on specific risks, identify possible threats in the development process of the in-house project, and improve the quality of the in-house project. The results of this study can aid system developers in understanding what type of risks they might encounter throughout the system development process. Moreover, project members can use these results as a guideline when proposing a comprehensive risk management plan for in-house project development. Project managers can learn crucial lessons from the risk management process for an in-house project and then reassess their previous development direction. In summary, the results of this study would enable the development of practical risk management mechanisms for in-house projects.

2. Literature review

2.1. Project risk management

The main aim of risk management is to identify risks that are likely to compromise the success of a project and thus must be controlled [20]-[23]. Lyytinen and Newman [15] suggested that the system development process involves the interaction between technical and social subsystems. Their theory assumes that the outputs of an IS are affected by the interactions between actors, tools, techniques, and tasks in the technical and social subsystems [13],[15],[24]. Therefore, the problems associated with and failures of IS projects have been attributed to not only technical issues but also organizational behavioral issues [21],[22]. When subsystems are dependent on each other, a plan must be developed to ensure that all subsystems coordinate their work and that the performance of the organizational system is maximized [13],[15],[24]. Therefore, technical and social perspectives must be considered in the risk management process related to the system development life cycle.

On the basis of the sociotechnical model, studies have defined four types of risks for IS projects [14],[17],[25]: risks related to tasks, structures, actors, and technologies. The task-related risks in an IS project include the requirements, goals, approaches, and products. Wallace et al. [20] found that ambiguity and creeping scope are critical task-related risks that affect the process outcomes of a project. Structure-related risks include risks related to communication systems, government structures, authority relations, schedules, physical arrangement, coordination mechanisms, and workflow in software development [21],[22]. According to Huang et al. [25], the risks involved in the enhancement of the fitness between organizations and enterprise resource planning systems include organizational culture, business processes, organizational adaptation, and resource allocation. These structure-related risks might lead to an increase in project cost or delayed project delivery. Actor-related risks include any attributes and capabilities of groups or individuals who affect or are affected by the achievement of project goals [12],[13]. These risks include unsatisfactory outcomes from different participants, poor skills, ethical problems, or the lack of actors. Beranek et al. [12] focused on user risks in the software development process and found that user participation is the primary actor risk. Finally, technology-related risks include risks related to how work is performed or to the methods, tools, infrastructure, and equipment used to develop and implement a software system.

Changes in any component of the sociotechnical model affect some or all the other components [15],[24],[26]. Risks occur if the interdependent relationships between technical and social subsystems cannot be managed at critical times of change. In the case of an in-house project, a structural change might affect the people involved, the technology that they use, and their defined tasks. In this study, we attempted to identify the risks involved in in-house software development projects.

2.2. Risks in the software development life cycle

Traditional project management methods, such as the waterfall method, and the Project Management Body of Knowledge focus on large projects and involve considerable documentation, standardization, and numerous planning and control processes; thus, they lack flexibility and agility for handling changes in management [28],[29]. Agile project management is characterized by frequent feedback loops and iterative reviews; thus, agile risk management emphasizes human factors, including communication, participation, and collaboration among stakeholders interested in the project, as well as the control of relevant resources [19],[30],[31]. Consequently, risk management is a crucial part of the software development process.

According to several authors [1],[9],[24],[27], in an IS project, users' requirements and the organization's strategic goals should be aligned with the developed technology applications and systems, which enables business needs to be supported while maximizing performance and minimizing risks. In in-house projects, business needs are met through the development of application systems, whose feasibility is examined through post-implementation reviews [7],[8],[30].

In the planning phase of an IS project, the project team conducts a feasibility analysis for the required system and then plans the project. Thus, risks related to system requirements, such as those related to uncertain, frequently changing, inadequate, and unachievable requirements, are primarily managed in this phase [20]-[23]. The managers and participants in an in-house project are insiders who are familiar with relevant business processes; therefore, these insiders can identify business requirements more precisely than can external personnel. In-house system development avoids the risk of escalated project cost caused by task complexity. The precise identification of business requirements can positively affect the project development process and lead to appropriate scheduling and adequate staffing [13],[18]. The participants of an in-house IS project define project tasks from only a business viewpoint; however, the task specificity and complexity might be higher than expected, and the designed IS might have inappropriate functions. The managers of in-house projects might possess sufficient knowledge and experience related to specific relevant tasks [4],[9]. Nevertheless, they face many challenges when integrating various business requirements and determining an appropriate project boundary under limitations related to factors such as time, budget, and human resources.

The objective of the analysis phase of an IS project is to translate project requirements into explicit system inputs, processes, outputs, and interfaces [18],[31]. In this phase, the project manager should consider the task-, structure-, and actor-related risks [13],[26]. In an in-house project, the project manager might not be concerned regarding inappropriate communication when identifying project requirements because the organizational cohesion might be high. Some project managers might face political conflicts, which can lead to power plays or inefficient communication [1],[7]-[9].

The objective of the design phase of an IS project is to convert the descriptions of analysis models into logical and physical system specifications. The risks related to the outcome of this phase include system functionality risks, resource usage risks, technology-related risks, and performance risks [18],[32]. In an in-house project, the integration of existing and new technologies leads to increased technology-related risks, such as those related to poor interfaces, system extendibility, and system maintainability [6],[17], as well as actor-related and structure-related risks, such as those related to inappropriate authority, poor coordination, and a lack of experience among staff in using a new technology.

In the implementation phase of an IS project, the designed system is constructed, installed, and maintained [7],[18]. Risks related to the satisfaction criteria of the project, such as the scheduling and timing risks, personnel management risks, and performance risks, are focuses in this phase [15],[16],[18],[32]. In an in-house project, when staff can effectively acquire sufficient knowledge regarding existing systems, the risk of using old technology can be decreased. However, the technical complexity and unfamiliarity toward new technologies are critical factors that lead to unrealistic expectations or a decline in technical performance when members of in-house projects are inexperienced in using new technologies. The characteristics of the different phases and risks involved in the software life cycle are summarized in Table 1.

Table 1. Characteristics of the phases and risks involved in the software life cycle

Life cycle Phase	Objectives	Risks
Planning	1. Identifies the system request 2. Feasibility analysis 3. Plans the project	1. Uncertainty requirements 2. Changing requirements 3. Inadequate requirements 4. Ambiguous requirements
Analysis	1. Translate the requirements specified into explicit terms of system inputs, processes, outputs, and interfaces	1. Changing requirements 2. Inefficient communication 3. Poor physical arrangements 4. Poor beliefs/skills/experience

Life cycle Phase	Objectives	Risks
Design	1. Convert the analysis models into logical and physical system specifications	1. System functionality risks 2. Resource usage risks 3. Technology-risks
Implementation	1. Build system 2. Install system 3. Maintain system	1. Scheduling and timing risks 2. Personnel management risks 3. Performance risks

In-house projects involve various risks that must be managed in the system development process. Therefore, this study examined the types of risks involved in in-house software development processes by investigating the frequencies of sentences related to these risks in interviews conducted with relevant individuals.

3. Methodology

The primary purposes of this study were to investigate the risks involved in in-house software development projects and to understand the evolution of these risks. In addition, we collected data that provide an experiential description of events, situations, and interactions between risks and the project in the entire system development life cycle. We conducted content analysis to identify differences in context, coded responses to open-ended questions in interviews, identified the intentions and other characteristics of participants, assessed the risks in the system development life cycle, and described the trends indicated by the data [33],[34].

We conducted a case study on in-house IS projects of different sizes conducted in different industries. Taiwanese manufacturing companies had an annual production value of more than 20 trillion New Taiwan dollars in 2021, and many Taiwanese companies have used technologies to enhance the efficiency, speed, and cost-effectiveness of manufacturing. These technologies were developed through coordination between various departments and involved big data sharing for supporting various business functions. In addition, the information technology (IT) service industry uses complex information systems to conduct daily operational processes and adopts in-house projects to maintain its competitive advantage. The risk management of these projects is critical when the manager faces challenges related to limited resources, security threats, and technology complexity. Thus, manufacturing and IT service industries are suitable cases for the present study. Cases related to power supply manufacturing, semiconductor foundry development in a manufacturing company, and a cloud computing service company were examined in this study. Moreover, the sizes of the projects selected for examination ensured that project portfolio analysis could be conducted on both a large and small scale.

To acquire a broad understanding of the risks involved in the entire IS development process, we recruited seven individuals from three companies who were working or had worked in different project roles. The responses of project managers and senior programmers to interview questions related to project risks are crucial because these individuals are involved in all phases of a software development project. All the participants in this study had at least 10 years of experience in managing projects. Three of the seven participants were project managers, and four participants were senior programmers. In this study, a “small” project was defined as one that lasted no more than three months, cost less than $50,000, had low functional complexity, involved no more than four team members, and had low risk. A “large” project was defined as one that lasted more than one year, cost higher than $500,000, had high functional complexity, involved more than 10 team members, and had high risk. Table 2 presents some information related to the participants.

Two researchers conducted participant interviews according to a predefined framework. First, the researchers obtained some basic background information regarding the project managers and the companies of these managers. Second, the researchers obtained information on project characteristics, including the project goals, budget, duration, members, and phases. Finally, the researchers obtained information related to risk management in the projects that the participants were or had been involved in. The shortest interview session lasted approximately 30 min; the longest session lasted approximately 90 min; and the average interview duration was 60 min.

In all the interviews, the researchers took notes, and the participants were encouraged to identify which issues were crucial to them in the context of their work. The coding scheme was defined according to the four components of the sociotechnical model proposed by Lyytinen and Newman [15] and the four phases of the system development life cycle proposed by Yu et al. [13].

Table 2. Information related to the participants and their companies

Case description	Case (Project)	Interviewees
Time >1 year Cost >$500,000 Project team members >10	1*	1 Senior programmer
	2**	1 Project manager, 2 Senior programmer
Time: 3 months~1year Cost: $50,000~$500,000 Project team members: 4~10	3**	1 Project manager
	4***	1 Project manager
Time <3 months Cost <$50,000 Project team members <4	5*	1 Project manager

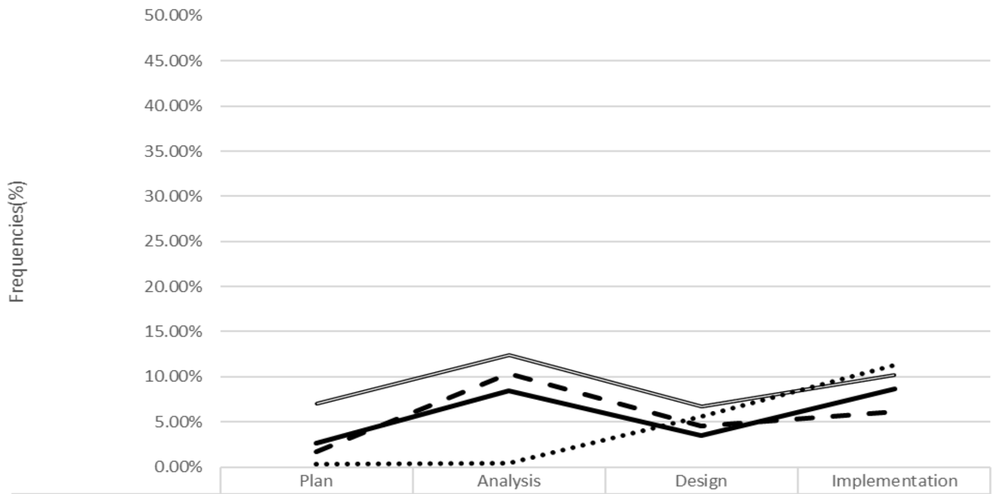
Note: * semiconductor foundry development and manufacturing; ** power supply manufacturing; *** cloud computing service provision

The two research assistants were trained to ensure that they coded units (i.e., themes) into suitable categories for reproducibility and reliability. The coding results of the coders were assessed by the authors of this study [33],[34]. To solve conflicts between the two coders, each coder was first asked to refer to the coding book, which contained the definition of each category, example, and keyword, to determine the correct category. The coders then had to explain their coding results and communication to each other to clarify the coding rules. Subsequently, the researchers joined the discussion to check each category's definition and helped solve the coding conflicts and eliminate coding ambiguities. The training data comprised 10%–20% of the entire data, and training lasted for several sessions until the intercoder reproducibility was approximately 90%. After training ended, the intercoder reliability values for software development risk and software development process were 92.10% and 91.33%, respectively. Subsequently, the coding rules were applied to all the data, and the official coding process began. Finally, after the official coding ended, the coder reproducibility values for software development risk and software development process were 91.72% and 92.89%, respectively.

4. Results and discussion

A total of 1,602 verbal sentences related to the four phases of the projects of the three considered companies were obtained in the interviews. The number of units used in the content analysis was 784. Of these units, 767 were classified into the software development risk or software development process categories. Frequency analysis was conducted on the four risk categories to compare the differences in project development patterns between the examined projects and to identify the characteristics of the four project stages. In Fig. 1, the *x*-axis represents the project phase, and the *y*-axis represents the frequency (in percentage) of sentences related to each risk category. Fig. 1 indicates that the frequencies of sentences related to the four types of risks differed. In the entire software development process, the highest sentence frequency was obtained for structure-related risks (38.1%). The frequencies of sentences regarding structure-related and actor-related risks peaked in the analysis phase. The frequency of sentences regarding task-related risks peaked in the implementation phase and was high in the analysis phase. The minimum frequencies of sentences regarding task-related and actor-related risks were obtained in the planning phase, and the minimum frequency of sentences regarding structure-related risks was obtained in the design phase. The frequency of sentences regarding technology-related risks increased during the last two project phases.

Overall, the results indicated that structure-, task-, and actor-related risks were the primary risks in the entire software development process. The participants mostly paid attention to task-related and structure-related risks during the first two project phases and to technology-related risks in the last two phases. The personnel working in the examined in-house projects had a common goal, worked under common staff management regulations, and adopted the same technology-based working process to achieve their aim. Thus, the project managers mainly focused on managing structure-related risks in the entire software development process. In addition, the managers adopted informal and formal communication systems to clarify projects tasks quickly. The administrative regulations might have aided the managers in meeting the project schedule and accessing appropriate human resources.



	Plan	Analysis	Design	Implementation
Task Risks	2.65%	8.42%	3.49%	8.67%
Structure Risks	7.01%	12.44%	6.75%	10.19%
Actor Risks	1.66%	10.40%	4.53%	6.11%
Technology Risks	0.37%	0.40%	5.60%	11.31%

Fig. 1. Frequencies of sentences regarding task-, structure-, actor-, and technology-related risks in the four software development phases.

4.1. Task-related risks

The frequency of sentences regarding task-related risks was high in the analysis and implementation phases (Fig. 1). The primary task-related risks were task ambiguity, continuous change, and task specification. The increase in the frequency of the aforementioned sentences from the planning stage to the analysis stage indicated that task-related risks were identified early in the projects and that the participants had strong business expertise and were familiar with the relevant business process. The frequency of sentences regarding task-related risks decreased considerably in the third phase. The increase in this frequency in the fourth phase indicated that task-related risks increased because of continual changes in the project scope or task specificity, which might have led to increased system complexity.

The results of our study are consistent with those of previous empirical studies [13],[15] that have indicated that the task requirements for users familiar with the relevant business domain are strongly associated with the task that is clarified at the beginning of the project. The project teams emphasized the identification of tasks-related risks in the analysis phase. Thus, the project team members might have quickly strengthened their business domain knowledge and experiences with regard to specific system requirements [1]. These skilled and experienced members affected the effectiveness of the requirements gathering and swiftly encouraged the individual part involved in the project. As such, a low level of task-related risk may assure business units of the viability of the project and enable the fulfillment business needs.

Continuously changing requirements and task specificity were the main task-related risks in the implementation phase. The project team members cooperated with other parties and exerted considerable effort in increasing the task specificity to fulfill each party’s requirements. On the basis of system requirements, the task specificity changed in the last project phase. Moreover, ambiguous task definition may limit the scope of the system, which has ripple effects on function suitability and system complexity. Project manager B said, “*Dealing with minor changes or discrepancies in requirements is unavoidable. Our project team must rebenchmark procedures on the basis of [requirement] changes or errors. At this point, we reassess the required workforce and adjust the schedule, hardware, and software…*.”

High task-related risk may exist in the early project phases; however, an increase in task-related risk should not be considered a negative phenomenon. The high frequency of sentences regarding task-related risks in the analysis phase indicated that the participants focused on the project requirements by clarifying and promoting users' involvement early in the project. The managers relied on users to identify complete requirements for the entire system. In the implementation phase, project team members frequently used sentences regarding task-related risks to indicate their willingness to collaborate with other members to develop correct system functions.

4.2. Structure-related risks

Consistent with the results of previous studies [13],[15], the participants of the present study focused on structure-related risks throughout the software development process (Fig. 1). The primary structure-related risks were an inefficient or poor communication system, poorly defined responsibilities, an inefficient governance structure, and inappropriate workflow and coordination. The sentences regarding structure-related risks guided the participants to connect with others who rapidly committed to their interests or group goals. In an in-house project, if structure-related risks are focused on throughout the entire software development process, a suitable communication system, responsibility policy, and governance structure in addition to good coordination and an appropriate incentive system can be maintained. For example, director E said, "*We need smooth communication systems to access resources for our project. First, we need to evaluate the feasibility of the IS project and assess whether it is worthwhile. Next, we have to check who should be involved in the IS project and support the IT and business fields. Finally, the timetable for each task should be arranged….*"

As depicted in Fig. 1 the frequency of sentences regarding structure-related risks was high for the analysis and implementation phases but low for the design phase. In the analysis phase [13],[23], task ambiguity lead to different interpretations or conflicts. To understand the project requirements clearly, project members had to share relevant knowledge and information through a communication structure, with most of them focusing on structure-related risks such as task assignment, communication through the chain of command, and the coordination mechanism or incentive system.

In the implementation phase, project members engaged in coordination or managerial processes, such as proposing the development of an IT strategy or integrating new technology with existing systems. Director A said, "*Based on the schedule, weekly meetings are held to review the timetable. In the earlier phase, revisions are made to paperwork only when miscommunication occurs… but the communication problems between IT staff and users are considerably more serious (cause a higher risk) than are those between IT staff and consultants. Fortunately, serious communication gaps between the technology and business units do not occur when they come to an agreement after frequent negotiations. In fact, good communication plays an important role in solving problems*." Consequently, sentences regarding structure-related risks frequently occurred throughout the software development life cycle, which indicated that the participants prioritized the development of a strong social relationship among project team members or the reinforcement of cooperative relationships to reduce any potential conflicts.

4.3. Actor-related risks

As illustrated in Fig. 1, actor-related risks were not a priority in the planning phase. The actor-related risks increased in the analysis phase and remained stable in the later phases. The major actor-related risks were the lack of actors, actor turnover, and ethical problems. Our data indicated that the actor-related risks were still serious during the last two phases of the software development process. The frequency of sentences regarding actor-related risks peaked in the analysis phase, which indicated that project team members had to manage coordination processes effectively to achieve the common goals of their project.

Project team members identified the actor-related risks in their project and then reduced the level of these risks by adopting appropriate human resources quickly and urgently coordinating with others. Project team members allocated human resources to decrease actor turnover to ensure that sufficient skilled actors were available for implementing the developed system. The project team members had to compete for resources against other teams within their organization. Specifically, human resources were the most critical resource within the organization. In the design and implementation phases, the members had to acquire appropriate knowledge. They defined project requirements in the analysis phase and transformed business needs into detailed specifications for guiding system implementation. Project team members should examine problems from both business and technical viewpoints. Senior programmer D said, "*Perhaps only certain people hold…key skills… In the beginning, we would rather find some people who are more familiar with IT because they can provide expertise. They see the whole picture of the IS project. Simply speaking, they coordinate more closely with the IT unit because they do not examine problems from only a business point of view*."

According to the aforementioned text, sentences regarding actor-related risks paved the way for coordination and conflict among project team members and allowed the manager to synchronize the functioning of business and technical teams. Furthermore, when actor-related risks emerged and were appropriately assessed, the project manager could effectively manage the low-level actor turnover, thereby solving conflicts among project team members. In summary, sentences regarding actor-related risks allowed each project team member to assess and adjust their needs, skills, responsibilities, and value in their project.

4.4. Technology-related risks

Consistent with previous research [13],[15], the frequency of sentences regarding technology-related risks peaked in the implementation phase (fourth phase, Fig. 1). In a successful in-house IS project, customized services can be developed by assessing the adoption of and satisfaction toward the newly developed system [1],[6],[19]. To provide high-quality technical services to internal personnel, members of the technical unit focus on new technologies, novel methods, technical complexity, technical maintainability, or scalability during the design and implementation stages. In an in-house IS project, considerable technology resources must be used for developing system functions that fit the tasks of the business unit. Thus, the project team members identified technology-related risks after the system requirements were defined in the first phase of the software development process.

During the last two project phases, project team members had to address many technology-related risks. In practice, technology-related risks include the need for alignment between legacy systems and the new system, the presence of massive historical data, the resistance of users to new technology, and changes in business processes. Project managers C said, "The development of new technology is a part of our work. But, frankly speaking, developing new technology or using new technology components is not the priority…. in fact, we have diverse data formats, complex system interactions, and different technology platforms…in the IS project, the critical activity is to take care of maintenance issues and system integration...alongside these, [personnel] training is a bigger issue."

An in-house project should never be treated as only an IT adaptation for managing technology-related risks. To develop a compatible, maintainable, and customizable IS, project team members should not only assess technology-related risks but also consider the possible interactions of technology-related risks with task-, actor-, or structure-related risks. These interactions can lead to the failure of IS delivery for specific business users. Therefore, in the projects investigated in the present study, in the final project phase, project team members identified and monitored all types of risks and more deeply understood the gap between business needs and technology. Managers of in-house IS projects should be proactive in ensuring that their existing systems and users can be integrated with the new technology platform and new business process.

4.5. Risks involved in large, medium-size, and small projects

Fig. 2 illustrates the frequencies of sentences regarding the four types of risks in large, medium-size, and small projects. No major difference existed between the frequencies of sentences regarding task-, actor-, and technology-related risks in these projects. In the case of small projects, the frequency of sentences regarding structure-related risks peaked in the planning and design phases; however, in the case of large and medium-size projects, this frequency peaked in the analysis phase. Thus, small projects entail different structure-related risks than large and medium-size projects do. Organizational culture, resource allocation, and communication structure might affect structure-related risks in an IS project.

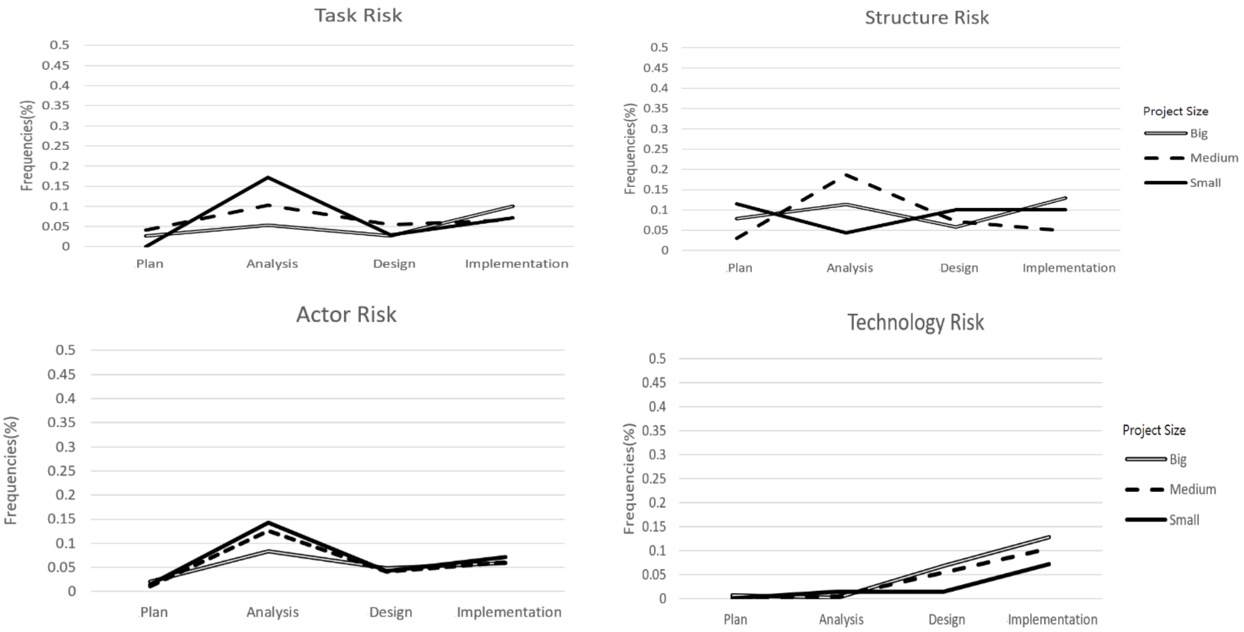


Fig. 2. Frequencies of sentences regarding task-, structure-, actor-, and technology-related risks in different phases of large, medium-size, and small projects

Table 3 presents the risks involved in general projects (examined in previous studies) and in-house projects (examined in the present study). In in-house projects, task-related risks are not the main concern because project team members are familiar with the relevant business process; however, in the last project phase, continual changes in project requirements change the scope of the developed system and might result in the development of wrong functions and system complexity. Although only insiders are involved in an in-house project, the level of structure-related risks, including communication, coordination mechanisms, or membership conflicts, in such a project may not be lower than that in general projects. Many actor-related risks are associated with the design phase of an in-house project. Project members must compete for human resources against other units in their organization to transform business needs into system specifications. The level of technology-related risks increases rapidly when the team members involved in an in-house project focus on not only the use of the newly developed technology but also the integration of the new system with legacy systems to deliver high-quality technology services to organization insiders.

Table 3. Risks involved in general projects and in-house projects

General projects (examined in previous studies)	
▪ Task-related risks are the primary target for management in the planning phase [13],[18],[20]-[23]. ▪ The project manager may be focused on task-, structure-, and actor-related risks in the analysis phase [1],[7]-[9],[13],[18], [26],[30]. ▪ The project manager focuses on technology-related risks in the design and implementation phases [6], [15]-[18], [31].	
In-house projects (examined in this study)	
Task-related risks	The level of task-related risks remains relatively consistent throughout the system development process and increases in the last project stage.
Structure-related risks	Structure-related risks are dominant throughout the entire project. However, these risks are not priority risks.
Actor-related risks	Actor-related risks are not priority risks in the planning phases, and the level of these risks remains stable in the later phases.
Technology-related risks	The level of technology-related risks is high in the fourth (implementation) phase.

In summary, the team members involved in the in-house projects examined in this study spoke sentences regarding task-, structure-, actor-, and technology-related risks throughout the system development process; however, the frequencies of these sentences were not the same. Sentences regarding structure-related risk dominated all the project phases; sentences regarding task-related and actor-related risks characterized the first two project phases (i.e., the planning and analysis phases); and sentences regarding technology-related risks characterized the last project phase (i.e., the implementation phase). Each type of risk pressured the project teams to reassess their weaknesses, examine the resource allocation in the project, and obtain possible solutions to problems. The managers of in-house projects must deeply understand the signs of each type of risk to ensure successful project implementation.

5. Conclusion

The findings of this study are as follows. First, according to our empirical data, structure-related risks are the main risks in the overall software development process. Actor-, task-, and technology-related risks interact with structure-related risks in this process. Technology-related risks are pronounced during the last two project phases (i.e., the design and implementation stages). Second, organization insiders participate in in-house projects, and these insiders work under the same regulations and project objectives. Thus, in an in-house project, the project team focuses more on structure-related risks than on the task-related and actor-related risks in the planning phase. Third, the project team of an in-house project focuses on structure-related risks because the project parties are business oriented. To eliminate the knowledge gap between the business and technology units, project team members must share their knowledge of their project domain and reach a consensus regarding the project value.

This study makes several contributions to the literature on risk management in in-house IS projects. First, by using the sociotechnical model, we identified four types of risks in the aforementioned projects: task-, structure-, actor-, and technology-related risks. The results of this study provide a preliminary understanding of the risks involved in different phases of in-house IS projects. We determined that the social subsystem is associated with actor-related and structure-related risks, and insiders might possess deep understanding regarding the business goals, requirements, and system functions associated with an in-house project. The technical subsystem is associated with task-related and technology-related risks, and the participants in an in-house project might know how certain technologies fit their organization. Second, this study examined the four identified risk types and found that structure-related risks are a major concern in in-house projects. In such projects, the management of structure-related risks is a priority because effective coordination may enable a clear definition of tasks, responsibilities, and incentives to align the actors, tasks, and technology in the project. Managers must consider the characteristics of the project to identify the main risks in the system development process.

In practice, project managers can manage risks effectively by adjusting the resource allocation appropriately to reduce specific risks in each phase of the software development process. In an in-house project, the project team might initially manage actor-related and task-related risks. However, project success is influenced by the coordination among various departments, which should be facilitated through the development of appropriate structures in all project phases. Therefore, managers of in-house projects should monitor structure-related risks. In addition, the participants of an in-house project must adopt efficient new technology, minimize technology complexity, achieve precise requirements, and use effective system development methods before the last project stage (i.e., the implementation stage).

Although this research offers valuable insights into the risks involved in in-house IS projects, it has some limitations. First, a major limitation of our study is that our analysis relied solely on Taiwanese interviewees who had been critical project participants for more than 5 years; thus, the results of this study may not be generalizable to all projects. Second, our study was an exploratory study with an ex post facto design, which can only indicate what was happening or what has happened. We used considerable data to understand project risks but could not determine the reasons that caused the evolution patterns of these risks. Despite the aforementioned limitations, the results of this study have crucial implications for the investigation of risks in in-house projects.

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