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Managing risks in information technology projects

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Managing Risks in Information Technology Projects: A Case Study of TradeNet

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ABSTRACT

The development and implementation of IT (Information Technology) projects are plagued with problems of cost and time overruns, technical inadequacy, inability to meet user requirements, lack of utilization, and failure to achieve anticipated benefits. These problems occur to some projects and not to others because 1) IT projects have different profiles of risk, and 2) IT project risks have been managed more or less effectively. This paper synthesizes the literature into four classes of risks, and applies it to evaluate TradeNet, an EDI-based trading system implemented in Singapore in 1989. Through a case study of TradeNet, we derived a typology of four risk management strategies for IT projects: 1) risk preemption, 2) risk reduction, 3) risk isolation, and 4) risk sharing. Each risk management strategy is described in terms of the tactics and mechanisms used in the TradeNet project. Some of these tactics include: positioning the system, providing incentives for adoption, managing project development, information and expertise, scoping the system, separating accountability, surfacing of problems, cooperating with organizations, coopting key personnel, and connecting to other systems. The relevance of these risk management strategies is analyzed and discussed.

As IT becomes more integrated with business goals and strategies, the impact of IT project failure on competitive outcomes will be felt more than before [6, 15, 36]. Keen [14] contends that, "many business managers are unaware of the range of IT-related risks to which the firms are exposed. They learn about most of them only through disaster." Past research has largely dealt with how IT risks may be assessed and compensated for by imposing a higher hurdle rate for project acceptance [8, 28]. There has been little empirical research on how IT project risks are managed during the project execution. The objective of this paper is to develop, from a case study of TradeNet[1], a typology of strategies that may guide managers in developing specific plans to control risky IT projects. In this paper, we discuss the concept of risk, and synthesize from the literature, criteria for evaluating risks. We then evaluate the risk profile of the TradeNet system, and empirically derive a scheme for classifying and managing IT project risks.

[1] TradeNet has been published as teaching cases [18, 26], and it should be referred to for background information. This paper describes TradeNet, not with a pedagogical view but with an analytical perspective, and draws from the TradeNet case, an understanding of how IT project risks may be successfully managed.

RISK MANAGEMENT: LITERATURE REVIEW

Risk is present in a project when key project performance indicators may not be achieved because of environmental uncertainties and unexpected variations in the amounts and quality of project inputs [3, 16, 23, 36, 38]. Risk is considered a negative factor in IT project assessment because of its downside exposure to cost overruns, time slippage, technical performance shortfalls, unrealized benefits, and retaliations from affected parties that may result in substantial business costs. IT project risk management involves two processes: evaluation of sources of risks before project commencement, and managing risks during project execution. The focus of this paper is the management of risks during the execution of a project.

The finance/investment literature addresses the risk evaluation process. A project is deemed to be attractive for investment if it generates a positive discounted cashflow, or has an internal rate of return greater than a predetermined hurdle rate [17, 32]. Risk is managed by having a diversified project portfolio, and undiversifiable risks are handled by raising the hurdle rate in project evaluation.

The project management literature describes tools and techniques for planning, organizing, and controlling resources (people, money, materials, etc.) to meet project specifications (features, functions, quality, etc.) within scheduled time targets [3, 16]. These techniques and tools (critical path diagrams, PERT charts, project reporting procedures, etc.) are believed to reduce risks in project execution, and are treated as universally applicable, with little attention for developing strategies that may enable managers to cope with different types of risks [35].

The importance of risk as a criterion for managing IT projects has been noted in the IS literature. Alter [1] suggested that analysis of risk factors would facilitate implementation success. McFarlan [23] argued that appropriate attention to risk management in the systems development life cycle would avert some common IT project fiascoes. He regarded risk as a basic contingency in managing projects: projects with different levels of risk ought to be managed differently. Davis [9] advocated that the selection of strategies for analyzing information requirements be based on the degree of requirements uncertainty.

Sources of Risks: Evaluating IT Projects

Identification of the sources of risk is essential for effective evaluation and management of IT projects. Four sources of risk (task, organizational, technological, and market) have been identified in the literature and are summarized in Table 1.

The **tasks** that are the object of an IT application affect its risks. The probability and impacts of failure are increased if IT is to be applied for complex and interdependent tasks requiring high levels of investments, if well-defined requirements are not available either internally or externally, if users and/or analysts are new and lack relevant experience, and if it leads to substantial structural and/or process changes in user areas.

The **organizational context** within which an IT application is to be used is another source of risks. The chances of failure are higher if users are skeptical about the project and participate only nominally or not at all, if the organization is new to computing, and if senior management support is lacking.

To the extent that **technological platforms** require substantial changes or are new, project risks are increased because of the learning time and performance uncertainties involved. On the other hand, if a project merely implements a standard application software with no major changes to either software or existing IT infrastructure, the technical difficulties would be fewer and overall project risks would be lowered.

Strategic IT projects tend to be more risky than traditional internal IS because of greater **market uncertainties** regarding the external competitive environment, the rate of adoption by external user groups, the likely pattern and timing of impacts, and reactions from affected firms. Even when initial success is achieved with an IT application, there are risks concerning the wider impacts of the system. For example, a successful strategic system may require continuous investments for sustainability, may result in greater dependence on IT vendors, may trigger strategic alliances among previously independent competitors, may trigger off competitive retaliations, and may simply divert management attention away from its core businesses.

Managing Risks during Project Execution

In a study of 56 decision support systems, Alter [1] suggested four major implementation strategies to cope with IT project risks: 1) divide project into manageable pieces, 2) keep the solution simple, 3) develop a satisfactory support base, and 4) meet user needs and institutionalize the system. Although a good starting point for investigating IT project risk management, Alter's strategies focused on the task, technical and organizational issues of developing internal systems and did not address the market risks that are often crucial to the success of inter-organizational systems.

McFarlan [23] described the factors of IT risks and discussed two major strategies for managing them: 1) have a portfolio of projects with different risk profiles and 2) use degree of project structure and newness of technology as criteria for deciding which project management tools to use. Although the suggested portfolio and contingency approaches are intuitively appealing, there has been little empirical data that describe their usage in executing IT projects. The project management tools (external integration tools, internal integration devices, formal planning tools, and formal control mechanisms) discussed by McFarlan dealt mainly with rational planning and control mechanisms. The only behavioral strategy discussed dealt with various aspects of user participation. Further, McFarlan was concerned with intra-organizational projects, and therefore did not address the competitive risks that arise for inter-organizational IT projects.

The purpose of this study then is to build upon the work of both Alter and McFarlan and extend them to include the behavioral and political strategies that are often needed to cope with the market risks of inter-organizational systems. This paper seeks to empirically derive a scheme for risk management from a case study of TradeNet.

Table 1
Sources of Risks in IT Projects

Categories of Risk Factors	AUTHORS: Alter 1979	McFarlan 1981	Davis 1982	Vitale 1986	Parker et al. 1988	Clemons 1991
Task Factors:						
Changes to System Features		X			X	X
Changes in User Departments	X	X	X		X	
Experience of Users & Analysts	X	X	X		X	X
Complexity of Tasks	X	X	X		X	X
Availability of Requirements	X		X		X	X
Size of Project/Investment	X	X			X	X
Organizational Factors:						
User Attitudes toward Project	X	X	X			X
Management/Political Support	X	X	X	X	X	X
Maturity in Use of Computing			X		X	
User Participation	X	X	X			
Technological Factors:						
Need for New Hardware	X	X			X	X
Changes in Operating Systems	X	X			X	X
Use of Standard Packaged Software					X	X
Changes in IS Infrastructure					X	X
Market Factors:						
Strategic Value of Project				X	X	X
Adoption by External User Groups					X	X
Vulnerability to Established Firms				X		X
Competitive Forces				X		X
Regulatory/Legal Environment				X		

A CASE STUDY OF A RISKY PROJECT: TRADENET

Since this study is concerned with *how* risks are managed in IT project execution, a case research methodology is adopted [2, 11, 19, 39]. The study's focus on management strategies required the collection of contextual information for which a case methodology is well suited. The development of the Singapore TradeNet system was chosen as an interesting case for study because it was both risky and successful. Studying such a case would provide valuable insights into successful IT project risk management that could be confirmed or extended with subsequent research. The data collection and analysis methodology for deriving the risk management typology is described in the Appendix.

The TradeNet System

TradeNet is an industry-wide EDI (Electronic Data Interchange) system that facilitates trade document processing in Singapore. International trade is characterized not only by the physical movement of goods across national boundaries, but also by the voluminous paperwork that accompanies it. Such documents contain data that show ownership, facilitate the physical goods movement (eg., destination), display attributes of goods, and enable governmental control over trade. TradeNet provided for electronic submission and approval of trade documents, replacing the paper-based, hand-delivered, and manual process that was used previously. With TradeNet's round-the-clock operation and pre-clearance procedures, traders are able to process trade documents prior to physical arrival of their goods and eliminate the need for warehousing at the port. Firms that were already computerised could transfer the necessary data from their own computer systems directly to TradeNet, thus eliminating duplicate data-entry and the errors associated with it.

The development of TradeNet was approved by the Singapore government's IT policy-making body, the Committee on National Computerisation (CNC) in late 1986, and

was publicly announced by the Minister of Trade and Industry in December 1986. Two government agencies, the Trade Development Board (TDB) and the National Computer Board (NCB), jointly developed the project. TDB's CEO headed an executive steering committee comprising CEOs of other government departments and representatives of several trade associations. NCB provided the project team that worked with the users to develop specifications for the system. In June 1987, 23 vendors responded to a request for information (RFI) concerning the potential technical solutions available for TradeNet. Three of the vendors were selected to submit more detailed proposals in August 1987, and IBM was invited to provide a full system design in December 1987. The system contract was awarded to IBM and signed in April 1988. Meanwhile, a new private company, Singapore Network Services (SNS), was formed in March 1988 to implement and operate TradeNet, and provide other EDI services. More information about the development and implementation of TradeNet are provided in subsequent sections describing the risks in the project and how these risks were managed. The riskiness of TradeNet with respect to task, organization, technology, and market factors is evaluated in the next section.

Risks in the TradeNet Project

Task factors. TradeNet was one of the biggest IT systems to be implemented in Singapore, costing more than S$20M, and its implementation affected many government departments and trading firms. The tight deadline, giving the project team only two years to specify, design, build and implement TradeNet, increased the likelihood of time slippage. The public commitment made by a prominent Cabinet Minister put substantial pressure for the project to be delivered on time.

Organizational factors. No single government agency had the knowledge, expertise or resources to implement TradeNet. It was assigned to both the National Computer Board (NCB) and the Trade Development Board (TDB) after several rounds of negotiations. NCB, responsible for national IT planning and manpower, lacked expertise in international trade. TDB had expertise in trade processing but then did not even have its own computer services department. The CEOs of both NCB and TDB, who had known and worked with each other for many years, decided to "join hands" on the project because both shared the strategic national vision for TradeNet. But NCB's CEO was transferred to head another key agency after the TradeNet project began. Further, Singapore traders were mostly small firms with little prior experience with business computerization.

Technological factors. EDI was a new technology to Singapore and required common data and document standards among users. Technological risk was also present in the selection of the vendor for the project. Although IBM owned the EDI software and had used it in other countries, the local IBM support staff did not have any experience with EDI. It was also the first time that IBM was licensing its proprietary EDI engine to a customer, and the usual processes for supporting customers were not in place. The TradeNet project required several major applications (eg., an accounting and billing system, and database services), which were subcontracted to a local software house, CSA. However, CSA had only worked with Digital platforms and TradeNet would be CSA's first IBM mainframe project, requiring it to use several IBM tools (eg., the Telon code generator) that were new to the company. Further, to develop the applications within the tight timeframe would require about 45 CSA staff, more than its entire staff strength at that time. New staff with new skills were required for the task.

Market factors. The legal enforceability of electronic transaction was not well established in 1986. Market acceptance of electronic trading systems was also uncertain at best. HongKong, which in 1984 had announced plans for its trade EDI system, Hotline, had made little progress because of resistance from the trading community. Further, large multi-national vendors like IBM and the General Electric Information Services already offered EDI services worldwide, and could easily enter the Singapore market directly or through strategic alliances. TradeNet would face severe competition from these companies if they do enter the local market.

From the above analysis, we conclude that the TradeNet project was fraught with high risks: it was a big project with tight public deadlines, needed new technology, required new business practices and procedures, lacked experienced personnel, used new organizational arrangements, experienced a change of CEOs at NCB after the project had started, and had uncertain market acceptance. Was the risky TradeNet project managed well? We next evaluate the outcomes of the TradeNet project.

Evaluation: Was TradeNet a Success?

We evaluate TradeNet using five criteria:

1. project management — were costs and time targets met?

2. system performance — did it achieve its objective of improving the turnaround for clearing trade documents? Was SNS profitable?

3. user adoption — how quickly was TradeNet adopted by users?

4. organizational impacts — did users benefit from using TradeNet?

5. diffusion of EDI — how did TradeNet affect the introduction of other EDI systems?

1. Project management

SNS processed its first pilot TradeNet transaction over the network in January 1989, marketed it as "live," and claimed to have met the target deadline for TradeNet implementation. Other users were allowed to use TradeNet from February. If usage by a pilot group in January cannot be considered as operational implementation, then opening up to the entire trade community in February certainly was. Given IS's patchy record for meeting crucial deadlines in systems projects, one will not find it difficult to accept SNS's claim of having met the target deadline even if it was "technically late" by one month.

Although there were no variations from cost estimates used in the feasibility study, which was based on the IBM contract price, the target was met at a price. Specification changes that would have resulted in additional IBM charges were postponed. Although SNS insisted that these were "non-critical" requirements, some users we interviewed complained about the non-availability of features like a UNIX interface. SNS was hardnosed enough to know that it could not hold cost as contracted, add functionality, and meet its target deadline all at the same time. In the end, they treated the deadline as imperative, held cost at the contracted amount, and sacrificed additional functionality.

2. System Performance

97% of all trade documents processed through TradeNet are approved by TDB within 15 minutes of submission, compared to the two-day turnaround time needed for the approval of paper-based documents. The fee for document submission through TradeNet has been kept low at S$6 per document, the same amount traders were paying even before TradeNet was conceived. At the same time, SNS revenues grew by about 50% a year from S$4M in 1989 to more than S$20M in 1992. It turned in a profit in its second year of operations, three years earlier than anticipated.

3. User Adoption of TradeNet

The adoption of TradeNet by user trading companies exceeded expectations. SNS surpassed what was considered to be aggressive targets for the volume of trade documents processed through TradeNet. These targets and the actual volume achieved are summarized in Table 2. In effect, TradeNet achieved the targeted steady-state trade documentation volume in less than two years, which was less than half the projected time. In fact, at the end of its eighth month of operation (August 1989), TradeNet had 500 subscribers, and processed 40% of all trade documents.

The overwhelming user response prompted TDB to announce its plan to phase out the manual trade processing system by 1992. User adoption after August 1989 was most likely influenced by TDB's announcement and may be difficult to attribute directly to the system itself.

Table 2
Volume of Documents Processed through TradeNet

Year	Target	Actual
1989	15%	45%
1990	40%	92%
1991	70%	95%
1992	90%	95%

4. Organizational Impacts

Some user trading firms reported 20 to 30 percent savings in labor and inventory holding costs, while others claimed that costs have risen because of the computing investments required to use TradeNet. Most traders claimed that benefits from TradeNet were important to them but intangible because their costs were relatively fixed and cost displacements were negligible. Our discussions with trading firms showed that the few firms that benefited most had integrated TradeNet into their operational procedures and systems. The testimonies of two CEOs of trading companies showed that the impacts of TradeNet on the trading community have been largely intangible:

> In the air cargo industry, speed is of essence. There is no point in having the best airline and the best airport to handle your cargo when it is delayed at the final leg of the transportation chain, which is cargo clearance with government authorities. TradeNet is a tool that air cargo agents can use to complete this final leg more efficiently. Our productivity has gone up as all shipments are cleared within the day.
>
> — CEO of an air freight forwarding company

> With the resultant shorter turnaround time for permit approval, our goods are cleared more speedily and efficiently. However, the lack of a Unix interface meant that we must still re-key information that would otherwise be available in our other computer systems.
>
> — CEO of a medium-size logistics company

The impact of TradeNet on TDB itself has been more dramatic. As of end 1992, the number of staff in TDB's documentation department has been reduced from 134 to 88, and its occupied floor space reduced from 1390 to 985 square meters. Further, the documentation staff at TDB has now taken on a more proactive role in improving trade procedures rather than merely ensuring compliance to existing trade procedures.

5. Diffusion of Other EDI Services

SNS has since built many new services on the basic EDI engine that cater to the diverse needs of other industry sectors. These include MediNet for the healthcare community, LawNet for the legal community, and many other generic services that provide for inter-organizational linkages between manufacturers, retailers, suppliers, and financial institutions. For example, hospitals are now able to transmit patient medical claims electronically through MediNet to the government for payment; retailers and manufacturers can transact by sending electronic quotations, purchase orders, invoices and tenders, and settle their payments through the electronic payment system offered by banks.

International links to business partners in the United States, Europe, and Japan, and access to information databases to support decision-making are now available to TradeNet users. These and other EDI-based services are continuously being introduced by SNS and are transforming the ways that businesses operate and communicate with their partners. These new EDI applications extend the usefulness of TradeNet and a firm can now integrate its trade processing requirements with its other business computing and communication needs.

Overall, using the five criteria as described above, we conclude that the development and implementation of TradeNet has been successful. In Singapore, EDI is no longer exclusively associated with trade documentation. It is increasingly seen as an enabling technology for all external communications and transactions. Because of TradeNet, EDI is now firmly entrenched in the business infrastructure of Singapore. How did SNS manage the risks in TradeNet? The risk management strategies that we found in the case study of TradeNet are discussed next.

RISK MANAGEMENT STRATEGIES IN THE TRADENET PROJECT

We classified the decisions and actions taken in the execution of the TradeNet project into four categories: risk preemption, risk reduction, risk isolation, and risk sharing. In subsequent sections, we define and describe each of the four risk management strategies and give specific examples from the case. The risk coping mechanisms in each risk management strategy are summarized in Table 3.

Table 3
Risk Management Strategies and Coping Mechanisms in the TradeNet Project

I. Risk Preemption
1. Positioning the system
   - Marketing the system
   - Obtaining high-level authorization and support
   - Demonstrating organizational commitment
2. Providing incentives for adoption
   - Facilitating switch-over
   - Adopting accepted standards for connectivity
   - Providing range of services

II. Risk Reduction
1. Managing information search
2. Managing expertise recruitment
3. Managing project development
   - Selecting qualified vendors
   - Instituting project control procedures

III. Risk Isolation
1. Scoping the system
2. Separating accountability
3. Surfacing of problems

IV. Risk Sharing
1. Cooperating with other organizations
2. Coopting key personnel
3. Connecting to other systems

I. The Risk Preemption Strategy

Preemptive strategies are first-mover attempts by an organization to secure an advantageous position over potential competitors [20, 21, 30]. Preemptive moves may be psychological or actual. Psychological moves involve signalling a firm's intentions to competitors to discourage potentially damaging competitive actions, and are effective when a firm has the resources and commitment to carry out its intentions. Actual preemptive moves may include new product introductions, capacity expansion, takeovers, and aggressive advertising.

The risk preemption strategy in IT projects may similarly be defined as attempts by an organization to secure an advantageous position for the system in the minds of customers and potential competitors so that actions damaging to the system may be avoided. From the TradeNet project, tactics used to preempt risks include: 1) positioning the system, and 2) providing incentives for adoption. Both tactics were aimed at preventing problems arising from lack of system adoption by potential customers, and potential competitive actions that might hurt the project. Specific risk preemption tactics in the TradeNet project are listed in Table 4 and are briefly discussed below.

1. Positioning the System: Positioning seeks to distinguish an IT system from others available to avoid organizational risks [7] by shaping the attitudes of interested parties, and gaining their participation in and political support for the

Table 4
The Risk Preemption Strategy

1. Positioning the System

- Marketing the System
  - Promote TradeNet as a strategic national project
  - Press releases about TradeNet's development at regular intervals
  - Publish speeches by prominent government leaders regarding TradeNet
  - Promote SNS as the national EDI vendor
  - Publish TradeNet success stories in SNS newsletters
- Obtaining High-level Authorization and Support
  - TradeNet decision made by high-level Committee on National Computerization
  - TradeNet project was announced by a Cabinet Minister
  - Obtain the Ministry of Finance's approval for setting up SNS
  - Obtain Auditor-General clearance on TradeNet's security procedures
  - Obtain Attorney-General statement on the legality of electronic transactions
- Demonstrating Commitment
  - Communicate commitment and non-negotiability of launch date
  - Commitment on project members' continuity from IBM, CSA, SNS and others

2. Providing Incentives for Adoption

- Adopting Accepted Standards for Connectivity
  - Adopt international EDI standard, EDIFACT
  - Publish Singapore EDI standards for vendors and users in 1987
- Providing Range of Services
  - Trade documents and procedures were streamlined
  - Caters to whole array of hardware interface platforms
  - SNS allows round-the-clock electronic submission
  - Pre-arrival clearance procedures
  - Provide full range of EDI services and applications
- Facilitating Switch-over
  - TDB sets target date for 100% conversion to electronic submission of trade documents
  - TDB raises fees for manual submission of trade documents
  - SNS sets low fees for using electronic trade clearance through TradeNet
  - TDB redeploys manual processing clerks; time for manual processing increases to two days
  - SNS sets target time for electronic clearance of documents at 15 minutes
  - Regular EDI seminars for managers and users
  - Full range of TradeNet training courses for different types of users
  - Certification of TradeNet user operators
  - Capability to simulate customer sessions for support and troubleshooting

Abbreviations
CSA: Computer Systems Advisers (local software house, subcontractor to IBM)
SNS: Singapore Network Services (TradeNetOperator)
TDB: Trade Development Board (responsible for trade policy and information)

project.

Marketing the system. SNS projected TradeNet as a strategic national project deserving the support of those who have Singapore's best interests at heart. By so doing, SNS preempted potential attempts to rob TradeNet of its importance and centrality, and secured the support and participation of government and business customers.

High-level authorization and support. Approval and support by powerful and authoritative figures gave TradeNet the legitimacy and credibility it needed to convince skeptics about its viability. For example, SNS got the Attorney-General's office to assure users of the legal enforceability of transactions effected through TradeNet. SNS also subjected itself to an audit from the Auditor-General's office and obtained a clearance on the adequacy of security procedures in the system.

Demonstrating commitment to successful project completion. SNS and IBM were committed to project team continuity to ensure that the project would be completed on time. For example, IBM was able to persuade the Ministry of Defense to defer one of its engineers from military training to avoid the risks of project delay. Such acts of commitment [31] demonstrated SNS's and IBM's resolve to meet key targets.

2. Providing Incentives for Adoption

Facilitating switch-over. The greatest threat to TradeNet was the traders' natural tendency to rely on existing

manual procedures. Actions taken to "encourage" early switchover included announcement of plans to convert to full electronic trade processing by January 1992, increasing manual processing fees from S$6 to S$10 a document while keeping fees for TradeNet users at S$6 a document, achieving a fast 15-minute turnaround for TradeNet documents, conducting EDI seminars and training courses to assist different users to learn the system.

Adopting standards for connectivity. The adoption of an internationally accepted standard, EDIFACT, gave TradeNet immediate legitimacy and enabled users to be plugged into global networks for electronic trading with business partners.

Providing range of services. Providing a wide range of system features made it possible to attract user groups with different needs and requirements. TradeNet provided for users of different hardware platforms (from PCs to mainframes), allowed round the clock electronic trading, clearance of documents prior to the physical arrival of goods, and provided access to other electronic information services.

Table 5
The Risk Reduction Strategy

1. **Managing Information Search**
   - Search professional journals for ideas and potential solutions
   - Visits to trading ports in Japan, Europe and USA in end of 1986
   - Send RFI (Request for Information) to potential vendors in April 1987
   - Visits to potential vendors' EDI installations in mid 1987
   - Obtain detailed system design from IBM in end of 1987
2. **Managing Expertise Recruitment**
   - IBM brought in internationally experienced personnel as program managers
   - IBM system engineers sent to Japan for training before working on the contract
   - IBM's TradeNet contract came under the supervision of its Asia-Pacific Group (Tokyo)
   - IBM's TradeNet design specifications were scrutinized by its Asia-Pacific Group
   - CSA recruited staff that had experience in an IBM environment
   - SNS's CEO personally recruited her management team
3. **Management Project Development**
   - Selecting Qualified Vendors
     - Only vendors with proven EDI experience were considered
     - Require vendors to provide total solution package
     - Use the vendors's ability to meet January 1989 launch date as selection criterion
     - Specially negotiated license for the use of IBM's EDI engine
     - Procedures to pre-qualify vendors for the user-interface software
     - Technical assistance to qualified vendors for the development of user interface software
   - Instituting Project Control Procedures
     - Project team has access to TDU specifications when designing TradeNet specifications
     - Functional groups of users set up to discuss and develop TradeNet specifications
     - Full functional TradeNet specifications ready in early 1987 (three months after announcement)
     - Budgetary monitoring and control procedures by IBM
     - Change control procedures agreed among IBM, CSA, and SNS
     - SNS adopts IBM test procedures for acceptance test
     - IBM delivers parts of the system to SNS continuously as they become available

Abbreviations
CSA: Computer Systems Advisers (local software house, subcontractor to IBM)
SNS: Singapore Network Services (TradeNet Operator)
TDU: Trade Dial-Up

II. The Risk Reduction Strategy

Two organizational approaches for reducing uncertainty are: 1) increasing information processing capacity [12], and 2) bringing elements of the environment under an organization's control [29]. Increasing information processing capacity reduces uncertainty by enabling an organization to access and assess more information about the future, and increase its ability to predict future events more accurately. In addition, an organization may seek to exert influence over key resource inputs or distribution channels (through joint ventures, strategic alliances, etc.) to control important business outcomes and eliminate the need to predict future events.

We define the risk reduction strategy as plans to reduce project uncertainty by increasing technical knowledge and information about the system, and the use of processes to exert influence and control over people involved in the project. In the TradeNet project, we found that this was done through information search, recruiting expertise, and managing the project development process. Specific risk reduction tactics are listed in Table 5, and are briefly discussed below.

1. Managing Information Search

Information needed for the TradeNet project were mainly directed at sources external to TDB and NCB, and were aimed at overcoming the project team's lack of prior knowledge and experience with electronic trading systems. A RFI (request for information) and a RFP (request for proposal) were used to obtain information from potential solution providers. Several overseas field trips were made to visit existing trade-related EDI systems. A project manager explained the purposes of these trips:

> We (the project team) were all new to trade EDI systems. Although there was a group at NCB that was monitoring developments in EDI, we had to do much fact finding and searching when TradeNet was launched. First, we had to understand what trade systems other countries were using. Then we had to understand what technologies were used. Of course we looked at the trade publications. We also wanted to look at trade systems firsthand to understand how they were used, what problems were encountered, and whether they were appropriate for Singapore. The project team visited several sea and airport systems in Japan, Scandinavia, the United Kingdom, and the USA. We saw both community trade systems and EDI-based systems. Although none of the systems could be directly used for TradeNet — what we were considering for TradeNet was bigger than all the systems we saw — it was really an eye opening trip for all the team members. After the trip, we were convinced that Singapore should go for EDI.

2. Managing Expertise Recruitment

Expertise recruitment is an information acquisition activity aimed at reducing risks arising from the project team's lack of prior knowledge and experience in trade EDI systems. For the TradeNet project, several groups of "outsiders" were brought in to reduce risks from a lack of task and technology experience. IBM sent several of its systems engineers to Japan for training on EDI systems, and brought in internationally experienced personnel as program managers. SNS also recruited several key people to form its core team. Most of the team members are now directors or departmental managers of SNS. One SNS director explained how he got involved in TradeNet:

> I was working for another organization when I received a phone call from the CEO of SNS. She told me about SNS, and invited me to join her team. I had worked for her for several years previously when I was in NCB, so I guessed she knew me and thought I could contribute to TradeNet. It sounded like an exciting new opportunity, and so I quit my job to join SNS. After I came on board, I found out that most of the other directors had also been personally recruited by the CEO. That was a very important factor. We worked with her and with each other very well. That was crucial during the hectic days of trying to implement the system and trying to resolve the operational problems. We could feel the team spirit as we worked together to achieve our goals for TradeNet.

3. Managing Project Development

Selecting qualified vendors. To complete the TradeNet development cycle in two years required that the core system be sourced from an appropriate vendor, and only modules that related to the Singapore trading environment be developed. Thus the main project development tasks involved selecting vendors to provide the needed solutions, and working with the vendors to ensure that specifications were complied with, and that quality, cost, and schedule targets were met. SNS negotiated with IBM a license agreement that gave it control over the EDI engine and support to function as an EDI service provider. For the application interface software, SNS selected four local software houses with experience and good reputation. SNS then provided specifications and technical assistance to these four vendors in their development of the interface software.

Ironically, the success of TradeNet and the faster than expected growth in EDI services have made the decision to license the EDI engine from IBM, which allowed SNS to implement TradeNet quickly, seemed shortsighted. As SNS responds to numerous requests for its services in the Asian region, it found that the terms of the IBM agreement, which prohibit SNS from selling or re-licensing the EDI engine to

third parties, to be restrictive to its long-term growth potential. SNS is now devoting 40 IT professionals full-time to build its own EDI engine so that it can provide total EDI services in Asia.

Instituting project control procedures. Project control procedures were closely followed to ensure that the system would be completed on schedule and meet specified requirements. During the specification stage, the team had access to key users and to the requirements for the TDU (Trade Dial-Up) system, a predecessor to TradeNet that linked airfreight companies to TDB for the submission of trade declarations. Besides the typical budgetary control procedures, change control was strictly enforced in the TradeNet project. Each change from the original specifications was evaluated in terms of financial costs and potential time delays. A vendor project manager commented:

> The greatest test occurred early in the project when SNS wanted some changes to the specs (specifications). We worked out the additional costs in dollars and schedule, and presented it in our weekly meetings. The whole place exploded. They felt we were outrageous. There were tense moments. Well, after the feelings settled somewhat, we managed to work through it professionally, and everyone finally accepted the basic principle that specs changes must cost something to the project. After that initial incident, we had no more quarrels about change control. The understanding about change control procedures was critical to our ability to deliver the system according to schedule.

SNS adopted IBM's procedures for acceptance testing rather than develop its own independent procedures. Being new to EDI, SNS adopted this practical approach to save time and to reduce risks from using inappropriate test procedures. IBM deviated from its norm of delivering only a fully completed system to customers by delivering modules of the system to SNS as they were completed. This procedure enabled SNS to become familiar with the system and reduced their learning time. SNS and IBM developed mutual understanding of each other's expectations and avoided many potential rifts during the development process. A SNS director commented:

> One of the most meaningful parts of the TradeNet project was that we developed good relationships with the vendor personnel we worked with. We developed mutual understanding. We became friends. Even today, a year after the project was completed, we still keep in touch, and feel that we had enjoyed working together on TradeNet.

Feasibility studies, functional specifications, RFI, RFP, visits to EDI installations, detailed system design, training, review and control procedures, and recruiting the right people for TradeNet ensured that SNS had control over important expertise, technology, and people. These helped overcome the potential problems associated with unfamiliarity with EDI technology and system-related tasks.

III. The Risk Isolation Strategy

Where risks cannot be preempted or reduced, a strategy of risk isolation serves to limit the potential impact of failure in one part to the rest of the project. It seeks to ensure that the overall performance of the project would not be severely affected even if some aspects are not done well. In insurance, risk isolation is achieved by identifying specific types of policies (life, health, fire, etc.) to cater to different types of risks, and calculating premiums that vary according to the risk profile of individuals or firms that buy those policies [10, 37].

We define the risk isolation strategy as the delineation and assignment of project segments to specific individuals or groups for better control, accountability, and problem resolution. Tactics for isolating risks found in the TradeNet project are listed in Table 6.

1. Scoping the Project

Project scoping involved decomposing the project into distinct parts or phases [1, 33] that may be separately managed, assigned, or subcontracted. Scoping is an appropriate tactic for isolating risks arising from large projects with many interested players and complex tasks. Scoping for TradeNet was done by implementing the project in four distinct but cumulative phases:

1. Trade declarations for non-dutiable items in January 1989;
2. Custom dutiable items in April 1989;
3. Trade control items in October 1989; and
4. Certificates of origin for exports to the US in April 1990.

The identification of these four phases enabled SNS to redefine the TradeNet launch as the implementation of the first phase. Scoping also enabled the team to focus their efforts at achieving more specific targets at regular intervals, facilitating problem identification and solution related to each phase

SNS persuaded 49 of the 50 Trade Dial-Up users as its pilot group, who proved to be enthusiastic users of TradeNet, and their experience was so positive that word quickly got around in the industry and other firms were clamoring to become users of TradeNet in February 1989, two months before the pilot phase was scheduled to end. SNS's CEO commented on importance of the pilot group:

> This pilot group became TradeNet's champions. They were the ones who were excited about using IT

Table 6
The Risk Isolation Strategy

1. Scoping the Project
Implementation of the air and sea manifests was postponed
TradeNet implemented in four phases ("milestones")
Position TDU as "pilot" projecct for TradeNet
SNS management visited and recruited TDU users to be TradeNet pilot users
EDI services added on after basic system is funcitoning

2. Separate Accountability
- Create separate entity
  Conduct feasibility study for setting up SNS as a for-profit company in 1987
  Create a separate legal entity, SNS, to implement and operate TradeNet in 1988
  Entire project team transferred from NCB to SNS in early 1988
  SIS (wholly owned by TDB) set up in 1989 to develop application interface software
- Subcontract
  Price Waterhouse commissioned to do study on information requirements of trading companies
  IBM subcontracted three major application modules to CSA
  Fixed-price subcontract to CSA
  Payments to vendors based on achievements of agreed-upon milestones

3. Surfacing of Problems
Weekly project review meetings among IBM, CSA, and SNS
Three-tier system test procedures by CSA, IBM and SNS
Active test approach to isolate problems rather than mere acceptance/rejection
Daily monitoring of service levels to customers
Weekly SNS meetings to address customer issues
CSA, IBM, and SNS project members developed good working and personal relationships

Abbreviations
CSA: Computer Systems Advisers (local software house, subcontractor to IBM)
NCB: National Computer Board (responsible for IT policy and planning)
SIS: Singapore Information Services
SNS: Singapore Network Services (TradeNet Operator)
TDB: Trade Development Board (responsible for trade policy and information)
TDU: Trade Dial-Up

in the trading industry, and proved to be enthusiastic TradeNet users. Other firms saw how TradeNet was benefitting this initial group of users and do not want to lose out. They knew that if they do not use TradeNet, they cannot compete on the same basis as the pilot group. Just the trade processing turnaround time would have put them in a tremendous disadvantage. They had to come onto TradeNet, and many did.

2. Separate Accountability

After decomposing the TradeNet project, groups like IBM and CSA were given responsibility for completing the tasks related to each part. The creation of SNS in 1988 to implement and operate TradeNet may be viewed as a risk isolation mechanism. When the project team was transferred from NCB to SNS in 1988, SNS assumed full responsibility for and became synonymous with TradeNet. If failure should result, neither TDB nor NCB's name would be tarnished. The creation of SNS placed full responsibility for TradeNet's success on SNS managers, an important motivation for performance since results were attributable to the new organization.

3. Surfacing of Problems

Another risk isolation tactic was aimed at surfacing problems and resolving them before other parts of the project were affected. Once problems had surfaced (and were isolated), attention was focused to ensure their resolution, and to control their impacts. Weekly meetings among project

managers of SNS, IBM, and CSA during development surfaced problems that were assessed in terms of their impacts on costs and schedule, and decisions were made on how they were to be resolved. A SNS director said:

> The managers who attended these weekly meetings could make decisions on the problems that were encountered. They had the authority to decide. They did not need to refer the decision upwards. In these weekly meetings, progress reports were made and then we zoomed in on the issues that required our attention. Because of the tight project schedule, everyone knew that they could not hide problems and get away with it. We wanted to know the problems up-front so that we could do something about it.

A three-tier test procedure was adopted whereby CSA did the modular tests, IBM the integration test, and SNS the system acceptance test. Even the acceptance tests were designed to highlight problems and areas to be addressed rather than a mere acceptance or rejection of the system delivered by the vendor. After TradeNet was launched, SNS monitored service levels (turnaround time, customer queries and complaints, etc.) daily to ensure that problems in the system were promptly addressed. System performance and TradeNet customer issues were top agenda items in SNS's weekly management meetings.

IV. The Risk Sharing Strategy

The fourth strategy utilized in the TradeNet project is risk sharing. Where risks cannot be avoided, reduced or isolated, we found attempts to spread the risks among several parties. In risk sharing, key parties are given stakes in the outcome of the project so that access to their resources and support (deemed to be important to the success of the project) may be obtained. It differs from the portfolio approach [23] in that the risk spreading occurs within a single IT project, not through having projects of varying levels of risk as advocated in the portfolio approach. The risk sharing strategy that we found in TradeNet is not unlike the strategy that Philadelphia National Bank adopted in launching MAC, its shared ATM network, to fight off the threat from Girard Bank, a competitor in the Philadephia area [5]. In the TradeNet project, we found mechanisms to get other organizations to have a stake in its success through formal cooperative arrangements, cooption of key personnel from other organizations, and connection to systems developed by other organizations. Tactics in the risk sharing strategy are listed in Table 7.

Table 7
The Risk Sharing Strategy

1. Cooperating with Other Organizations
- TDB-NCB partnership in developing TradeNet
- Four major interested parties take up equity interest in SNS
- TDB takes up majority equity interest (55%) in SNS
- IBM teams up with local software vendor, CSA, to develop TradeNet
- Mainframe time-sharing arrangements with Computer Engineering Services

2. Coopting Key Personnel
- TDB's CEO leads Steering Committee
- User CEOs appointed onto Steering Committee
- Representatives from user companies appointed to work with the project team
- Deputy CEO of NCB also appointed CEO of SNS in early 1988
- CEO of SNS also appointed CEO of SIS
- Key managers from statutory boards and trading firms appointed so SNS's Board

3. Connecting to Other Systems
- Link to PortNet for seaport users in 1989
- Provide access to databases in 1990
- Link to General Electric Information Services in 1990
- Link to Societe Internationale de Telecommunications Aeronautiques in 1990
- Link to Teleview (national IT network for households and businesses) in 1991
- Link to Fujitsu network in 1991
- Link to air freight community network (StarNet) in 1991

Abbreviations
CSA: Computer Systems Advisers (local software house, subcontractor to IBM)
NCB: National Computer Board (responsible for IT policy and planning)
SIS: Singapore Information Services
SNS: Singapore Network Services (TradeNet Operator)
TDB: Trade Development Board (responsible for trade policy and information)

1. Cooperating with Other Organizations

Strategic partnerships were formed for major aspects of the TradeNet project. TDB and NCB jointly accepted responsibility for TradeNet. SNS was owned by four major government statutory boards with charters for trade, civil aviation, seaport operations, and telecommunications, ensuring their support for TradeNet even if they had capabilities to develop systems to rival TradeNet. When TradeNet was implemented, it was operated on an IBM 3090 that belonged not to SNS, but CES (Computer Engineering Services), through a time-sharing arrangement. SNS bought its own mainframe in 1991.

2. Coopting Key Personnel

Influential leaders from various government departments and business firms were also coopted to be members of the TradeNet steering committee and by working with the project team. Highly regarded IT managers were appointed to key positions in SNS. Key members from statutory boards and industry associations were also appointed to SNS's board of directors. The steering committee chairman commented:

> We wanted the influential industry and statutory board CEOs to contribute positively by being members of the executive steering committee. We told them that TradeNet was a national project, aimed at enhancing Singapore's international competitiveness. That was our rallying point. When we sent out invitations to these CEOs to serve in the TradeNet steering committee, everyone accepted.

3. Connecting to Other Systems

System linkages involved linking the TradeNet system with other systems and services. Connecting to other systems allowed TradeNet to reach out to the users of other systems and to increase the EDI utilization (of other EDI value-added services like access to trade databases) of its customers. System links also reduced the risks of exposure to potential competition from other systems providing similar services by effectively reducing customer incentive to switch to competitive systems. Customers need only learn and maintain one system since other systems can be accessed through TradeNet.

Shortly after its launch in 1989, TradeNet was linked to PortNet, which was implemented by the Port Authority in 1984 to allow electronic access by shipping agents. In 1990, TradeNet was linked to several trade-related databases and a few large international networks. Links to the General Electric Information Services network provided TradeNet users access to 5,000 potential business partners worldwide and the link to the Societe Internationale de Telecommunications Aeronautiques network provided access to more than 25,000 airlines, freight companies, and customs administrators around the world. In 1991, a link was established to the Fujitsu network, giving TradeNet access to 18,000 users in Japan.

Strategic alliances, stock holdings, representation on boards of directors, personnel cooption, and system linkages were useful in sharing the potential success of TradeNet with external parties, thereby shoring up support for the implementation and utilization of TradeNet. Instead of resisting TradeNet, trading firms, influential managers, and owners of potential rival systems were given incentives to make TradeNet a success because of their association and links with, and stakes in the project.

MAPPING RISK MANAGEMENT STRATEGIES TO TYPES OF RISKS

The usefulness of each risk management strategy for dealing with different categories of risks in TradeNet has been discussed in the preceding paragraphs, and is summarized in Table 8.

Organizational and market risks are largely political, and may result in internal resistance and external retaliation to project implementation [22, 25]. A risk preemption strategy was effective in countering such political risks in the TradeNet project by raising the perceived image of TradeNet to that of a strategic national competitiveness project, and by providing practical incentives for its adoption. By using both tactics, potential competitors to TradeNet were preempted from resisting or retaliating because they neither have the psychological legitimacy nor the experiential difficulties from which they could gain political support for their cause.

Task and technology risks arise from the rational application of technology to solve task-related problems. Task complexity, user and analyst inexperience, and technology newness contribute to risks of time and cost overruns, and inadequacies in system performance. Techniques, tools, and tactics to counter these technical risks are well documented in the project management literature and were rationally utilized in the development of TradeNet. We have grouped these techniques, tools, and tactics as risk reduction and isolation strategies.

Different tactics classified under the risk sharing strategy were used in the TradeNet project to mitigate either political or technical risks: while personnel cooption were used extensively to gain needed political and customer support to overcome risks from organizational and market factors, interorganizational linkages were strategically used to obtain needed technical services, knowledge, expertise and people. The risk sharing strategy may have the potential for mitigating both political and technical risks in other projects as well.

The above mapping, based upon what we found in TradeNet, may also be used prescriptively to guide managers in developing plans to manage risky IT projects. Since the mapping was developed with data from only one case, it

Table 8
Usefulness of Risk Management Strategies for Various Categories of Risks

Risk Management Strategies	Categories of Risks			
	Task Factors	Organization Factors	Techonolgy Factors	Market Factors
1. Risk Preemption				
Positioning the System		X		X
Providing Incentives for Adoption		X		X
2. Risk Reduction				
Information Search			X	
Expertise Recruitment	X		X	
Project Development	X		X	
3. Risk Isolation				
Scoping the System	X			
Separating Accountability	X		X	
Surfacing Problems	X		X	
4. Risk Sharing				
Cooperating with Organizations	X	X	X	X
Coopting Key Personnel		X		X
Connecting to Systems	X	X	X	X

should be taken to be only tentative, and future research should validate it with a bigger sample so that it may be used as a generalizable framework for guiding practice.

SUMMARY AND CONCLUSIONS

We have synthesized from the literature, major categories of risks (Table 1) and used it to evaluate the risk profile of TradeNet. From a case study of the TradeNet project, we have developed a classification of risk management strategies and described the tactics used in the TradeNet project under each category. We have also mapped the strategies to their usefulness in managing different types of risks in the TradeNet case.

Implications for Management

The discussion of the types of risks, risk management strategies, and the mapping of the usefulness of strategies for different types of risks may be used by managers as an analytical framework for understanding the risk profile of a project and making explicit plans to counter the risks involved. Although the tactics described in this paper are based on what was done in the TradeNet project and are by no means comprehensive, we believe that we have provided a useful starting framework around which managers may develop a tailored strategy for each major IT project. Our mapping in Table 8 suggests that depending on the types of risks present in a project, different risk management strategies may be considered.

By examining the sources of risk in each project and the actions needed to overcome those risks, managers can explicitly consider the acceptability of the project before large investments are made. If a decision to proceed is made, the typology developed in this paper allows managers to plan consciously to minimize the risk of failure. The typology of risk strategies may also be used in project review meetings to monitor project progress and determine if additional steps may be needed to ensure that desired outcomes are being achieved.

The strategies described in this paper go beyond the traditional rational project management tools for managing risks and thus could be used by managers to ensure that organizational and environmental factors are carefully considered when formulating plans. When the framework suggested in this paper is utilized, it forces managers to explicitly consider the crucial political and market issues that are often not addressed in normal project management tools and techniques.

The risk management strategies in our typology are described in business management terms and avoid technical jargon often used in systems development techniques. It thus provide a working language for IT managers to communicate plans for controlling crucial IT projects to senior business managers who must feel comfortable about major technology projects before allocating funds or resources to their development and implementation.

One caveat is in order here. The study of IT project risks management was conducted in the context of a pro-IT culture initiated by the Singapore government. While lessons and ideas may be transferable to other contexts, it would be unwise to ignore some Singapore-specific contextual factors that may not be found in other environments [27, 34]. Such factors include the small size of the country, the close social networks among senior government and business leaders that make cooperation in inter-organizational projects more likely, a positive environment whereby private sector participation in the formulation of government economic and technology plans is encouraged and recognized, and a strong telecommunications infrastructure and government computerization program that were already in place when TradeNet was implemented.

Implications for Future Research

We recognize that the classifications and mappings described in this paper are based solely on what we found in the TradeNet project, and must be further elaborated and refined with more cases before it can be generalizable to other IT projects. Thus future research should study how risks are managed in other projects and the relative efficacy of different strategies. For example, it is conceivable that the risk sharing strategy may not work in a situation where the focal organization does not have the requisite power to coopt personnel from or have access to the resources of other external organizations. When a larger set of cases is assembled, future research should thus study the contingencies for the use of different risk management strategies in projects with various characteristics and organizational settings.

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APPENDIX: METHODOLOGY FOR DATA COLLECTION AND ANALYSIS

Data for the study were collected primarily through extensive interviews, and secondarily through reviews of hundreds of pages of project documents, reports, feasibility studies, system specifications, third-party reports, user training materials, brochures, and newsletters. The research team also attended courses designed for TradeNet users, and saw how the system was used in several organizations. A team of three researchers interviewed twenty-two managers who were involved in the development of TradeNet. They included members of the executive steering committee, project development and implementation team, vendor project managers, and user managers.

Since there was little past research on risk management strategies in IT project management to guide the structuring of data collection, the researchers followed Alter [1] recommendations by asking interviewees the following open-ended questions that dealt with the project evaluation (questions 1 and 2 below) and execution/implementation (questions 3 to 10 below) of the TradeNet project:

1. Describe the process and events leading to the decision to develop TradeNet.
2. What were the objectives for TradeNet?
3. Describe the process by which TradeNet was designed and developed.
4. What were the steps taken to ensure the successful development of TradeNet.
5. What aspects of the development process were you most satisfied with?
6. What aspects of the development process were you least satisfied with?
7. Describe the process used to implement TradeNet.
8. What were the steps taken to ensure the successful implementation of TradeNet?
9. What aspects of the implementation process were you most satisfied with?
10. What aspects of the implementation process were you least satisfied with?

Each interview lasted about two hours, and all except two interviews were taped. The taped interviews enabled the researchers to review the data to ensure accuracy and reliability in coding and analysis. In addition, the researchers spent many hours over several meetings with the TradeNet project manager who also served as the primary liaison for the research team. These meetings provided the team with background on the TradeNet project and served to clarify ambiguities arising from the interviews.

Qualitative data analyses were performed to derive an empirically based typology of IT risk management strate-

gies. Following Glaser and Strauss [13], Miles and Huberman [24] and Eisenhardt [11], the research team analyzed the qualitative data for answers to two questions: 1) What characteristics of TradeNet affected its risks (the evaluation process)? and 2) What were the actions taken to cope with the risks (the execution process)?

Each researcher reviewed the data and noted the issues relevant to the two questions. The research team then met to compare notes and discuss areas where there were different perceptions concerning the data. On several issues, phone calls to interviewees were made, and the taped interviews were consulted. There were 92 items on the consolidated list of risk coping mechanisms.

The list was reviewed and several alternative classification schemes were discussed. Eventually, through an iterative process, a scheme emerged that enabled the authors to classify the coping mechanisms into four risk management strategies: 1) risk preemption, 2) risk reduction, 3) risk isolation, and 4) risk sharing. Then within each risk management strategy, we looked for common themes among the coping mechanisms to form clusters. Clusters of coping mechanisms within each strategy were given names that reflected their common theme.