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– The case of Software Industry

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Abstract

This research investigated the use of web-centric collaborative techniques and methods for the software industry new product development (NPD) process. After carefully reviewing previous literature, a questionnaire was designed targeting individuals who currently work on or previously participated in the software new product development (NPD) process for the past six months. The survey was launched through the third-party web researching company, *InsightExpress*, where 200 completed surveys were collected.

As the observation from the results of this research indicates, the web-based level of collaborative tools does increase the level of integration between different departments in the NPD process. However, the impact of web-based collaborative tools on either overall performance or performance elements (technical success, financial success, budgetary, time-to market or schedule) is not evident. Moreover, the level of adapting web-based collaborative tools in the software industry is still not as popular as it was anticipated to be.

KEY WORD: NPD, software, collaborative tool, web-centric, web-based, survey, questionnaire.

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Executive Summary

Objective:

The primary objective of this research is to investigate the use of web-centric collaborative techniques and methods among the software new product development (NPD) processes with regard to the overall project performance.

Motivation:

Over the years, the time-to-market of new project development of software products has become more and more critical due to the blossoming of Internet growth. The importance of collaboration development has been stressed more and more often because of the globalization of corporations. Theoretically, web-centric collaborative tools should be one of the best solutions for these problems. In addition the use of web-based level of collaborative tools in software industry should theoretically be superior to other comparatively lower-technological industries. Hence, this research was motivated with the expectation to obtain results regarding the great benefits of web-based collaborative tools and high level of web-based software utilization in the software industry.

Research process:

The research process can be separated into two major elements: data collection and data analysis.

First, a web-centric survey was conducted through *InsightExpress*, a web research and survey provider. The target respondents were 200 online individuals who were currently working in the software industry, and who either currently were working on or previously participated in the software NPD process during the past six months. This study used a non-experimental approach: descriptive, difference, and associational research questions were investigated. Twelve research hypotheses were examined over fourteen structured questions.

Second, the dataset contained 200 subjects with ninety-three local variables and fourteen global variables that were analyzed from three aspects: univariate, bivariate and multivariate. The global variables include: the role, the size, the product type, the product complexity, four performance elements, the overall performance, the level of web-based Information

Technology (IT) systems, the internal use of communication tools, the external use of communication tools, the value of the tool, the benefits of using collaborative tools, the purposes of using collaborative tools, the barriers of collaborative tools, and the functional integration. Each global variable contains one or more than one local variables from each question. The univariate data analysis section (chapter 5) explained the dataset descriptively with respect to each global variable, whereas the bivariate data analysis section (chapter 6) cross-examined all local variables by statistical correction matrix (or equivalent test for nominal variables, significance level = 0.05, 2-tailed). However, to simply the problem, the results from bivariate data analyses are still interpreted in a global variable viewpoint. Finally, in multivariate data analysis section (chapter 7), several factor analyses were conducted against all local variables with significant relationships from the bivariate section.

Results summary:

In summary, six out of twelve hypotheses were accepted, two were only partially accepted, and the remaining four hypotheses were rejected. The types of software being developed by the subjects were found having significant impacts on the use of web-centric collaborative tools (both the purpose of using collaborative tools and the types of web-based IT systems being used). The impacts are higher on the external communication to the supplier or customers than the internal communication between project members. In addition, the web-based level of IT systems in a company is generally consistent. Moreover, the subjects who currently have access to web-based collaborative tools are giving positive feedback on the value of the tools.

However, it appears that the use of web-centric collaborative tools only contributes to the level of integration between project members rather than to the overall project performance as expected. The results have shown that the overall project performance may have been influenced by the combination of the level of web-based IT systems, the internal and the external use of communication tools. However, this combination can only explain approximately 57% of the total variance. Therefore, there are still some factors that this study failed to identify.

Conclusion:

The findings of this research suggest that the web-based level of collaborative tools in the software industry is unexpectedly lower than anticipated.

Chapter 1: Introduction

1.1. New product development (NPD) process

Today not only has globalization made New Product Development (NPD) more competitive, but also high-tech recession is aggravating this situation. In these circumstances, how to make correct product selection decisions in the NPD process, such as go/no-go choices with limited corporate resources has become one of the most critical issues ever for product managers.

New product development (NPD) is the process through which a product comes to market. NPD is among the most complex of human endeavors, involving such distinct disciplines as manufacturing, marketing, design, testing, finance, sales, organizational theory, and strategic planning. To give an example: An automobile has over 10,000 parts. Its development requires three or more years of effort from 750 to 1000 people within the manufacturing organization, and hundreds of other people in supporting companies. Moreover, an airplane can have over 1,000,000 parts, and its development may involve 3000 to 5000 engineers, at the cost of several billion dollars. With so many resources at stake, organizations cannot afford inaccurate information passed haphazardly among poorly integrated teams. (CIPD, 2001) Thus, the need of cross-functional integration has been stressed in the industry, especially in large corporations. (Clark, K.B. and Fujimoto, 1991)

The term “*new products*” in this research refers to products (e.g., software, tangible objects) commercialized by a firm and new to this firm, even though similar products may already have been on the market. (Clark and Fujimoto, 1991)

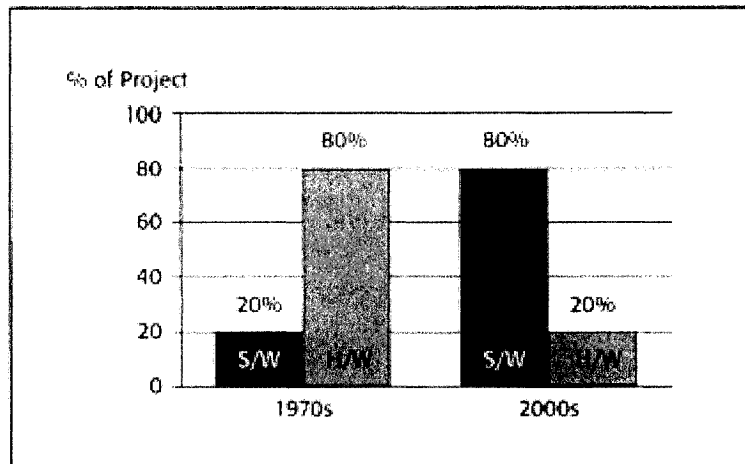
For large corporations with global facilities, the ability to collaborate remotely and effectively is crucial for project success. Therefore, how collaborative product management could facilitate the NPD process has obtained great attention. Thus, this research is designed to reveal current practice of one of the most important roles in collaboration: communication methods and tools.

1.2. Software product management

As we can still recall, less than three years ago the Y2K problem made our lives uneasy and insecure. It taught us a double lesson; how people today cannot live without software,

and also how important the quality of software is. In fact, the development of software projects has dramatically increased in the past few years according to Bennatan (2000). Based on his statement, the number of software projects has taken over the dominant position of hardware projects from the early 1970s to the year 2000. (See Figure 1)

Figure 1: The changing ratio of the software projects in the total hi-tech projects.



(Bennatan, 2000, Figure 1.1)

It is not only the dramatic increase of software development projects in the past few years that have brought attention to this research, but also the special characteristics of the software project development process. First of all, according to E.M. Bennatan (2000), the development of software projects is well known for rarely being delivered on time. Even if the projects do arrive on time, most of them either have shortcomings or lack major functionalities. However, the time to market is especially critical to software projects. Once a consumer behavior gets fixed, unless the software product offers superior performance, the odds of dominating the market would decrease dramatically or even eventually disappear.

Second, over the past decade, the blossoming of the Internet has changed the development environment of software projects. More and more software projects are already being developed on the Internet. This circumstance has made the software industry prioritize the adoption of web-centric collaborative tools.

The use of web tools for product development collaboration is still not common in some other industries. According to Original Equipment Suppliers Association (OESA)¹ (Macfarlane, 2001), traditional means of communication (such as telephone, fax, e-mail,

¹ Tools used for collaboration: email 95%, phone & conf. call 90%, meetings 90%, and MS office tools 70%.

and face-to-face meetings) still account for a significant portion of collaborative activities in the automotive industry, where only 15% of companies are using web tools for collaboration.

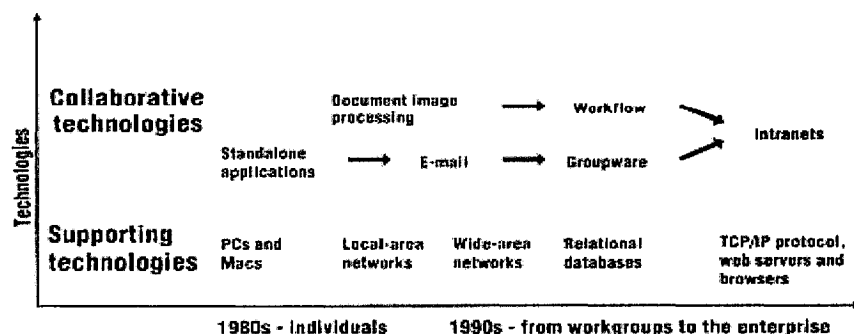
Thus, because of the nature of the software product development process, the high-tech based software development industry has the potential to obtain the most advantage from collaborative product development for the following reasons. First, it is expected that most software development engineers be well trained to adapt new software platforms. Therefore, comparatively, we presume the resistance to the use of collaborative product development software from software engineers to be minimal. Second, the larger the software developed, the higher the amount of source-code being maintained and exchanged electronically among project team members.

1.3. Collaborative techniques and methods

There are many techniques and tools that have been applied to facilitate cross-functional integration and collaborative management in the NPD process. However, in this research, we will be focusing on the “software” that facilitates the NPD process. By definition, software is a general term for the various kinds of programs used to operate computers and related devices.²

One of the earliest software terms that have been used for years in this field is “groupware”. Groupware is software for enabling collaboration within and between companies. It spans a wide range of software that enables teams of people to work together efficiently. Email software, for example, enables team members to exchange information in an unstructured way. For popular groupware packages such as Lotus Notes or Microsoft Exchange, they offer much more. (Chaffey, 1998)

Figure 2: The evolution of collaborative and supporting technologies



(Chaffey, 1998 Figure 1.2)

² WHATIS.COM, http://searchwebservices.techtarget.com/sDefinition/0,,sid26_gci213024,00.html

Groupware provides possibilities for people to communicate even if the traditional means of communication such as face-to-face contact are not possible. The computer networks (Internet, Intranet, Extranet, you name it) on the other hand, accelerates the speed and the range of communication. Figure 2 shows the evolution from groupware to intranets.

Web-centric tools, which are one of the most effective communication tools now available, has also been applied to facilitate the NPD process. According to the workshop held by OESA last year in April (Macfarlane, 2001. p. 19), the market for collaborative product development software, solutions, and exchanges has become extremely crowded in the year 2000. Table 1 categorizes the collaborative systems and shows how people can use collaborative tools to work together in time and space.

Table 1: Different uses of collaborative systems classified in time and space

	Synchronous	Asynchronous
Same location	Same time, same place Example: meeting support software	Different time, same place Example: workflow systems
Different location	Same time, different place Example: video-conferencing	Different time, different place Example: e-mail and discussion groups

(Chaffey, 1998 Table 1.1)

1.4. Objective of this research

The combination of everything previously mentioned, the use of web-centric collaborative methods and tools for the NPD process in the software development industry is the major subject of this research. The proposed research seeks to determine whether the use of collaborative product development in low technology industries is similar to that in higher technology-oriented industries, such as in software development companies. Moreover, by understanding the source of resistance, the proposed research explores the possible solutions and maximizes the potential advantage of collaborative product development.

The objectives of the proposed thesis include the following:

- To differentiate the influence of high technological communication tools and less technological tools on the software NPD process;
- To measure the efficiency of web-centric collaborative tools in the software NPD process between different development partners;

- To identify potential barriers of collaborative product development tools in the software development industry and to explore possible solutions;
- To observe the trend of the use of web-centric techniques and to provide further research possibilities.

1.5. Chapters of this thesis

The materials in this thesis have been divided as follows:

- Ch.2. Theoretical framework:** in this chapter, previous work related to the subject will be reviewed.
- Ch.3. The relevancy of the research problem:** the purpose of this chapter is to explain the methodology of conducting this research and to pre-examine/foresee the possible results. In other words, the research process and hypotheses will be given in this chapter.
- Ch.4. Data collection:** this chapter explains the method of obtaining the data required for this research. The questionnaire using for this study will be explained into details.
- Ch.5. Data analysis, part I – univariate analysis:** a brief description of the results, including the description of the subjects, the description of the use of the communication tools, and the description of the level of integration. Furthermore, the findings from cluster analysis (if any) will be given in this chapter as well.
- Ch.6. Data analysis, part II – bi-variate analysis:** the relationships between the subjects, the use of web-based communication tools, and the level of integration will be cross-examined (using cross-tabulations, chi-square tests and One-Way ANOVA analyses) in this chapter.
- Ch.7. Data analysis, part III– multivariate analysis:** the correlations among all variables will be explored in this section with factor analyses.
- Ch.8. Conclusion and future work:** this final chapter evaluates the findings of this research. The scope of this study and future work will also be discussed.

Chapter 2: Theoretical Framework

2.1. A glance at previous work

The theoretical framework of this research can be divided into several sub-subjects. Likewise, this section will present the research of past research papers into three categories:

□ **Part I: The New Product Development (NPD) process**

The purpose of the research in this area is to clarify different stages of the process of New Product Development and to determine the criteria to measure new product development performance later on.

□ **Part II: NPD with collaborative tools**

As mentioned earlier, there are many collaborative tools that can be used in the New Product Development process. Thus, research to discover tools other than web-centric tools can be useful as a comparison to find out the effectiveness of the web-centric tools.

□ **Part III: NPD with web-centric collaborative tools and Collaborative Product Commerce (CPC)**

Finally, research in NPD with various web-centric collaborative tools was conducted. Collaborative Product Commerce (CPC), for one, is a specific market dedicated to web-centric collaborative software. CPC has only been brought into the market for about two years and it is still considered as a new concept.

2.1.1. Part I: New Product Development (NPD) process

From an amount of contemporary research related to this field, the superior NPD performance of Japanese companies has played an important role since 1980s, for example, Clark & Fujimoto (1991) investigated this issue based on several different measures such as: time to market; Total Product Quality (TPQ); manufacturing productivities; internal/external integrations; Project Manager (PM) organization; project and corporate strategies; supplier and customer management, Japanese companies have proven their abilities to be superior than their counter competitors in various sectors.

However, in the 1990s, competition was already driving convergence among other international competitors. (Clark, K.B. & Fujimoto, T., 1991) Hence, the gap between

Japanese companies and their western counterparts will be set-aside in this research. Instead, the links and behaviors between supplier-manufacturer and manufacturer-customer from Japanese experience will be taken into consideration as the design of the questionnaires proceeds.

The performance measure for the NPD process is one of the most important key factors to conduct this research. Based on the research of Hertenstein and Platt (2000), the performance measures for the NPD process can be divided into financial and non-financial measures. It has shown that the best measurements are closely related to a company's strategy. Additionally, non-financial measures are more useful since financial measures often come out much later than NPD work. Further, it is difficult to separate the contribution between NPD and other departments in the organization. In the preceding research, they have also found that the use of a repeatable NPD process is more likely to succeed in the market. Therefore, the documentation of the NPD process is also considered as an important point for the design of investigative questionnaires.

An amount of research has addressed different approaches of improving the efficiency and effectiveness of the NPD process in different aspects. Zhao, Kumar, and Stohr (2001) proposed two new e-mail mechanisms in relation to information distribution.

Furthermore, a large number of Research and Development (R&D) directors were concerned about their limited involvement with key functional groups and interfaces (Gupta, 2000). Can this issue be solved with web-centric collaborative techniques and methods, which will be discussed later in this study? In addition, the degree of senior level involvement will also be investigated in this survey.

2.1.2. Part II: NPD with collaborative tools

Depending on the approach, different collaborative tools bring various influences to new product development process. In this case, web tools are neither unique tools nor the most efficient tools. Many of the project team members and project management representatives stressed that electronic communication was driven by the need to exchange information, not so much by the new technology itself (Hameri & Nihtila, 1997). From the researcher's personal past experience, most engineers refuse to take their "valuable" time to adapt new technology. To most R&D engineers, any tool other than designing equipment is too time consuming. They prefer using traditional means of communication (such as telephone, fax, e-mail, and face-to-face meetings). Hence,

engineer training is an important key to the success of adapting leading edge communication tools, especially for large corporations.

Second, web tools are not the only tools that assist in the NPD process. Group Support System (GSS), for one, has also been used for years in this field. GSS, by definition, is a subset of groupware. It enables participants in a meeting to simultaneously and anonymously deliver their ideas and comments in meetings. All the information are recorded in real time and electronically. GSS software also provides decision-making analysis abilities, and thus increases the effectiveness of the NPD process. (Muller, Engelen, & Terlous, 1996)

2.1.3. Part III: NPD with web-centric collaborative tools and Collaborative Product Commerce (CPC)

Web tools have been used in various collaborative activities. For example, Hameri and Nihtila (1997) conducted distributed new product development project research on Internet and web tools. They investigated the use of web tools to facilitate file-transfer activities among networked team members in the corporation. According to this case study, the greater the amount of collaborative activities among product development team members, the more sophisticated software required.

Another issue that has been stressed is the changing requirements of new product development over time. During the duration of the product development life cycle, the requirements of collaboration change often due to a variety of reasons, such as: supplier requests, customer feedback, resource reallocated, etc. The results of these changes can be seen from different angles. Supplier and customer involvement in the early stage, for one, has been integrated into the NPD process by web tools to eliminate engineering changes (Huang & Mak, 2000).

Since the technologies that make “Collaborative Product Commerce” possible have only been developed over the last two years, the research in this area is still limited. It seems that CPC could theoretically not only shorten the NPD lead-time but also decrease IT department workload. Previous experience shows that to achieve the functionalities such as linking Supplier and Component Management (SCM) and Customer Relationship Management (CRM) would either bring lots of input and maintenance tasks to Information Technology (IT) departments or become too time-consuming to engineers who were unfamiliar with such tools. Can CPC really overcome such difficulties?

Furthermore, CPC would involve writing special application interfaces, over different operation systems, and in many cases, by the time it is achieved the project or process will have moved on, such that the result will be either obsolete or inadequate (Rayson, 2001). Hence, is CPC good for small projects? Is it cost-effective? The answer still remains unclear and was reluctantly being investigated in recent research.

Finally, what are the real barriers that might stop CPC from spreading across high-tech companies? Is it a security, user interface or pure relationship integration issue?

The real niche of the web tools still remains unclear to various different sectors. For sectors that are less high-tech sensational, would leading edge communication tools hinder reform rather than promote it?

2.2. NPD in the software development industry

Due to the nature of software development, the need for web-based collaborative software for the NPD process is greater than in any other industry. The most important reason that the NPD process in the software industry is so demanding is the lifecycle of software products in the Internet age. The impact of the Internet makes software development cycles shorter and shorter, and the need to get software products to the market earlier is more important today than ever. However, the research in this field is still sparse. One of the reasons that researchers of the NPD process did not choose the software industry is the difficulty of evaluating software projects.

2.3. Collaborative product development

What is remote collaborative product development? According to *Best Practices Report* (Lasser, 2001b):

“Remote Collaborative Product Development is not outsourcing, where products are divided into modules, and then a module is farmed out in total to another organization. Nor is it a joint venture, where two groups fund a third group to get a desired result. Remote Collaborative Product Development is performed either at multiple sites within an enterprise, or beyond the enterprise, where it involves more than one organization; it involves at least one representative from each site actually participating in the creation

of a joint deliverable. The deliverable must contribute to the success of each party to the collaboration and yield a solution for an unmet need.”

Figure 3 shows how the increased use of remote collaborative product development has changed the status of collocated employees over the past three years. As a result of adapting remote collaborative product development:

- 10% decrease in the number of collocated employees on product development projects;
- 8% increase in the number of remote non-employees on product development (Lasser, 2001b).

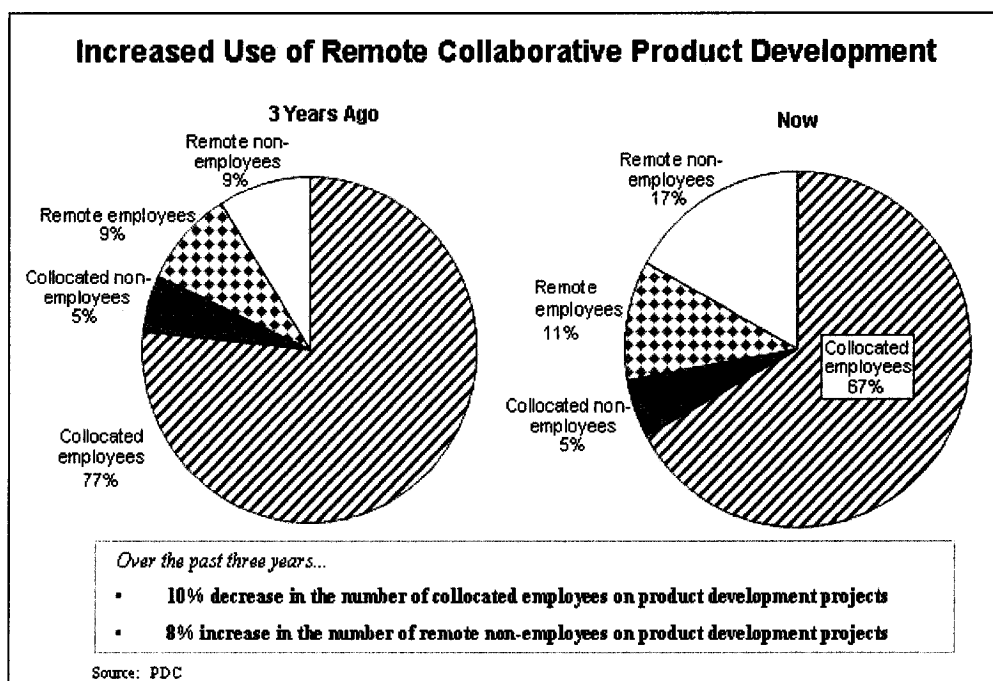


Figure 3: Increased use of collaborative product development over the past 3 years (Lasser, 2001b)

However, currently almost all companies seem to lack of the capability to identify the effectiveness of web-centric collaborative tools.

Before this research, the assumption of the use of web-centric collaborative tools in software development companies can be divided into three categories: implementation, adaptation, and maturation.

- Stage 1: Implementation

Among this group of companies, traditional means of communication tools dominate the NPD process. There are several possible scenarios in these companies:

First possible scenario: there is no web-centric collaborative communication tool, nor is any implementation plan. Software developers are simply satisfied with current condition. The challenge here is to discover whether they do not encounter any communication problem or they have not discovered the beauty of web-centric collaborative tools. Moreover, this research is also interested to find out the effectiveness of these companies, in terms of the NPD process, compared to companies that are adapting web-centric collaborative tools.

Second possible scenario: there is no web-centric collaborative tool currently implemented, but the companies are either planning to usher in this kind of system or the construction is already under way.

– Stage 2: Adaptation

In this stage, team members make their best effort to transform the information distribution process for NPD from traditional means of communication (face-to face, phone, fax...etc.) to web-based collaborative tools. There will still be debating on the pros and cons of web-based collaborative tools between team members. However, intensive on-the-job training can eliminate the controversy. Hence, the opinion from higher-level management is very important to the success of this stage.

– Stage 3: Maturation

In this stage, the benefits of web-centric collaborative tools start to pay off. As the technology matures, team members get more familiar with the procedure. The time wasted on the operation of web-centric collaborative tools is reduced to a minimum and the speed of information sharing doubles.

The benefits of web-centric collaborative tools have been identified as:

- Reduce project cost by saving shared project management spaces;
- Reduce travel cost and working hours associated to face-to-face communication;
- Reducing time-to-market by as much as 25%;
- Project status can be monitored by executives using Internet browser software from any remote location (Lasser, 2001b);
- Reduction in paper dependency.

However, it is worth noting that web-centric collaborative tools do not entirely replace traditional means of communication, but they do provide higher-level managers additional alternative solutions for communications, either internal or external.

2.4. Current market of collaborative software

While the technology of collaborative software is still the first generation (Lasser, 2001b), there is already plenty of software available in the market. Table 2 shows partial list of CPD software available in the market. (Bourke, 2000)

Table 2: List of available CPD software (Partial)

Company Name	Type	Comments
Agile software (www.agilesoft.com)	PDM	Positioned as collaborative product manufacturing source; see also ASP AristaSoft
Alibre (www.alibre.com)	CAx	Primarily mechanical-CAD oriented, with PD; support for design collaboration; ASP service and 3D solid modeling accessibility
Applicast (www.applicast.com)	ASP	ERP (SAP), PDM (Agile Software) and CRM (Siebel)
APPS4BIZ (www.apps4biz.com)	ASP	ERP, CRM and supply chain management
AristaSoft (www.artistasoft.com)	ASP	Vertical focus on high-tech equipment providers; partners with Agile to offer Agile Anywhere and other Tier-1 application vendors for ERP (JD Edwards) and CRM (Clarify and Selectica)
Aspect Development/i2 (www.i2.com)	CSM	Consolidated i2-Aspect-SupplyBase solutions to be offered as the broader design collaboration solution from i2 for the mid-market
Centric (www.centric.com)	DCS	PIVOTAL for collaborative virtual product development
Clarify (www.clarify.com)	CRM	See ASP AristaSoft
EOnline (www.eonline.com)	ERP	Primarily for SAP hosting; Siebel (CRM) and Ariba also supported
IMB Product Lifecycle Management Solutions (www.ibm.com)	PDM	ASP plans not ready for announcement at publication time; newly announced alliance with Dassault, i2 and Siebel to integrate PLM with SCM and CRM

(Bourke, CPIM 2000. Partial marketing data)

Table 2 shows only part of the list from market data obtained in 2000. It indicates that many companies have been working on this area and have produced a variety of different products. However, since there is still no consistent terminology to define each CPD software application, the software market creates an enormous burden for its customers. In addition, there is a great difference among pricing models for these sources. Undoubtedly, the already crowded market and complex CPD software with hundreds of providers would soon become one of the obstacles to the adaptation of web-centric collaborative tools.

Chapter 3: The Relevancy of the Research Problem

3.1. Methodology

The proposed methodology for this study can be split into two phases:

- Phase I: Questionnaire surveys and data collection
- Phase II: Data analysis

3.1.1. Phase I: Questionnaire survey and data collection

First, after carefully reviewing past literature, a survey aiming at current use of collaborative tools was created. The questionnaire for the survey was designed according to the objectives of this research in mostly structured format. Based on previous sections, key issues and components related to the use of leading-edge collaborative tools were identified in this stage.

The questionnaire covers the following topics:

- Current web-based level of information technology (IT) systems;
- Current use of collaboration tools and communication methods for external and internal team members in the software NPD process;
- The influence of collaborative tools on the performance of the NPD process;
- The benefits, purposes, and obstacles of collaborative tools;
- The impacts of collaborative tools on the level of integration among NPD companions;
- The opinions and feedback from high-level management to leading-edge collaborative tools.

Secondly, after designing the first draft of the questionnaire, a number of oral interviews were conducted with software product managers and software developers who have participated in various software NPD projects. The purpose of conducting these interviews was to ensure the quality and relevancy of questions contained in the questionnaire. The format of these interviews was semi-structured.

Then, the revision of the questionnaire was transformed into web-ready format in order to launch a web survey through a 3rd party on-line survey provider. Here, a small range of market research to find a suitable 3rd party on-line survey provider was performed in order to maximize the cost effectiveness. The method of sampling procedure will be discussed in more detail later on in the next chapter.

Next, a final draft was submitted to the on-line survey provider, *InsightExpress*, for final review. Some revisions were transferred back and forth via email to ensure both wording and content were respondent friendly and easy to understand. Again, a number of software product managers and developers were chosen for the test run and provided feedback via email.

Finally, the survey was officially launched after the approval of the final version of the questionnaire from both the research supervisor and the account manager of *InsightExpress*. The final version of the questionnaire is attached as one of the appendices of this paper (see: Appendix I *Questionnaire for the research*). The target of 200 samples was collected within three weeks. This is the final stage of data collection. The research then moved to the next phase, data analysis.

3.1.2. Phase II: Data analysis

In this stage, the goal was to investigate the dataset obtained from the previous stage with quantitative data analysis techniques. The data analysis was performed with three different approaches: univariate, bivariate, and multivariate data analysis.

First, the univariate analysis uses plain descriptive tools, such as pie charts, bar charts, and histograms to present the results from each question. Chapter 5 provides a brief description of the univariate data analysis. Second, as for bivariate data analysis, this research uses SPSS (version 11.0), which is one of the most popular statistical software packages, as the principal data analysis tool. A number of functions from SPSS were used, such as contingency tables, chi-square tests, scatter plots, and regression analyses. The statistical methods applied here are relatively simple: Ordinary Least Squares (OLS) regression for project-level data and Spearman rank order correlation for organization level data. The latter was adopted to avoid the potential problems of a small sample size. Table 3 shows the ground rules for bivariate data analysis applied in this research. All tests evaluated statistic significance by 2-tailed at $p > 0.05$ (p : TYPE I Error rate).

Table 3: The ground rule for bi variate data analysis

\	Ordinal	Nominal
Ordinal	Corrections and Gamma test	Phi and Cramer's V
Nominal	Phi and Cramer's V	Phi and Cramer's V

Finally, we use one-way ANOVA and factor analyses techniques from SPSS to perform multivariate data analysis.

3.2. Research Hypotheses

This study used a non-experimental approach. Descriptive, difference and associational research questions were investigated. The following research hypotheses were examined:

H₁: Team members who work in different roles on the projects use collaborative tools for different purposes.

Based on our previous software development experience, different roles in a project have complete different viewpoints on the NPD supportive tools. The use of web-centric tools can be dramatically influenced by the role of the project.

H₂: The web-based level of collaborative tools is positively related to the size of the company.

The dependant variable of this hypothesis is the web-based level of collaborative tools, and the independent variable is the size of the company. To test this hypothesis, the size of a company should not only be evaluated by one variable. However, due to the limitation of resources (the number of questions), this research only uses the number of employees to determine the size of a company. Theoretically, project team members of a large company will be located in spread out geographical locations. Hence, the web-based level of collaborative tools is expected to be higher in larger sized companies than in smaller companies.

H₃: The larger the size of the company, the harder the transformation of web-based collaborative tools.

The dependant variable of this hypothesis is the barrier of web-based collaborative tools and the independent variable is the size of the company. The barriers that might be influenced by the size of company include both “technical” and “non-technical” obstacles.

H₄: The subjects who develop different types of software products use different web-based IT systems.

The development process for each type of software product changes from time to time. Hence, the user behaviors of web-based IT systems between different types of software

product are expected to vary. The dependant variable of this hypothesis is the web-based IT system and the independent variable is the type of software product.

H₅: The subjects who develop different types of software products use collaborative tools for different purposes.

Similarly, the use of collaborative tools for people who work on different types of software products should somewhat be different. The dependant variable of this hypothesis is the purpose of web-based collaborative tools and the independent variable is the type of the software product.

H₆: The more complex the software products, the higher the use of web-centric collaborative tools.

The dependant variable of this hypothesis is the web-based level of collaborative tools and the independent variable is the complexity of a software product. A project tends to get more complicated when the complexity of the product gets higher. Hence, it is expected to see higher web-centric level of collaborative tools in a company of more complex software development projects.

H₇: The project performance elements are positively related to the use of web-centric collaborative tools.

Prior to this research, the advantages of web-centric collaborative tools had been evaluated as reducing time-to-market, cost effectiveness, and higher level of senior level involvement. Therefore, the impact of web-based collaborative tools on the performance measure elements such as budgetary and organizational (schedule) is of interest to this study. The dependant variables are the performance elements and the independent variable is the use of web-centric collaborative tools.

H₈: The overall project performance is positively related to the use of web-centric collaborative tools.

Since web-centric collaborative tools can affect so many significant elements of the NPD process (similarly to the description from H₇) they are expected to contribute to the overall project performance. Therefore, this hypothesis tests if a project performance would be higher with the use of web-centric collaborative tools. The dependant variable is the overall project performance and the independent variable is the use of web-centric collaborative tools.

H₉: The web-based level of each IT systems is interacted with other IT systems within one company

There is no reason that one company uses only one single web-based IT systems. Moreover, if the employees are familiar with the web-based interface, it can be expected that the company would be more willing to adapt more web-based IT systems. The dependent variable is the web-based level of IT systems and the independent variable is the web-based level of other IT systems.

H₁₀: The web-centric level of IT systems tools has higher impact on external communication than internal communication.

With traditional means of communication methods, such as a phone or a fax machine and the travelling for face-to-face meetings, the cost of communication is always higher on external communication. Hence, with web-centric collaborative tools, it can be expected that the cost will also reduce more in external or long distance communication. The dependent variable is the internal / external use of communication tools and the independent variable is the web-based level of IT systems.

H₁₁: The value of web-based collaborative tools is positively related to the use of web-centric collaborative tools.

With the confidence in web-centric collaborative tools, we expect to demonstrate that the subjects who have experience using web-centric collaborative tools will have high satisfaction on the value of web-centric collaborative tools. The dependent variable is the value of web-centric collaborative tools and the independent variable is the web-based level of IT systems.

H₁₂: The level of integration is positively related to the use of web-centric collaborative tools.

The level of function integration is a very important factor to the success of a NPD process. Thus, we expect to disclose the advantages of web-centric collaborative tools on the level of functional integration among the NPD organizations. The dependent variable is the level of integration and the independent variable is the web-based level of IT systems.

The following list is a list of each hypothesis with the corresponding variables and questions:

	Hypothesis	Dependant Variable	Independent Variable	Corresponding questions
1	H ₁	Purposes	Role	Q2, Q13
2	H ₂	IT systems	Size of the company	Q3, Q8 (Q9, Q10) ³
3	H ₃	Obstacles	Size of the company	Q3, Q14
4	H ₄	IT systems	Type of product	Q4, Q8 (Q9, Q10)
5	H ₅	Purposes	Type of product	Q4, Q13
6	H ₆	IT systems	Complexity of the product	Q5, Q8 (Q9, Q10)
7	H ₇	Performance elements	IT Systems	Q6, Q8 (Q9, Q10)
8	H ₈	Overall performance	IT Systems	Q7, Q8 (Q9, Q10)
9	H ₉	IT Systems	IT Systems	Q8
10	H ₁₀	Internal/External communication	IT Systems	Q8, Q9, Q10
11	H ₁₁	Value of the tool	IT Systems	Q8, (Q9, Q10), Q11
12	H ₁₂	Functional integration	IT Systems	Q8, (Q9, Q10), Q15

³ The questions in bracket are only partial related to the specified hypotheses.

3.3. Variable relationships

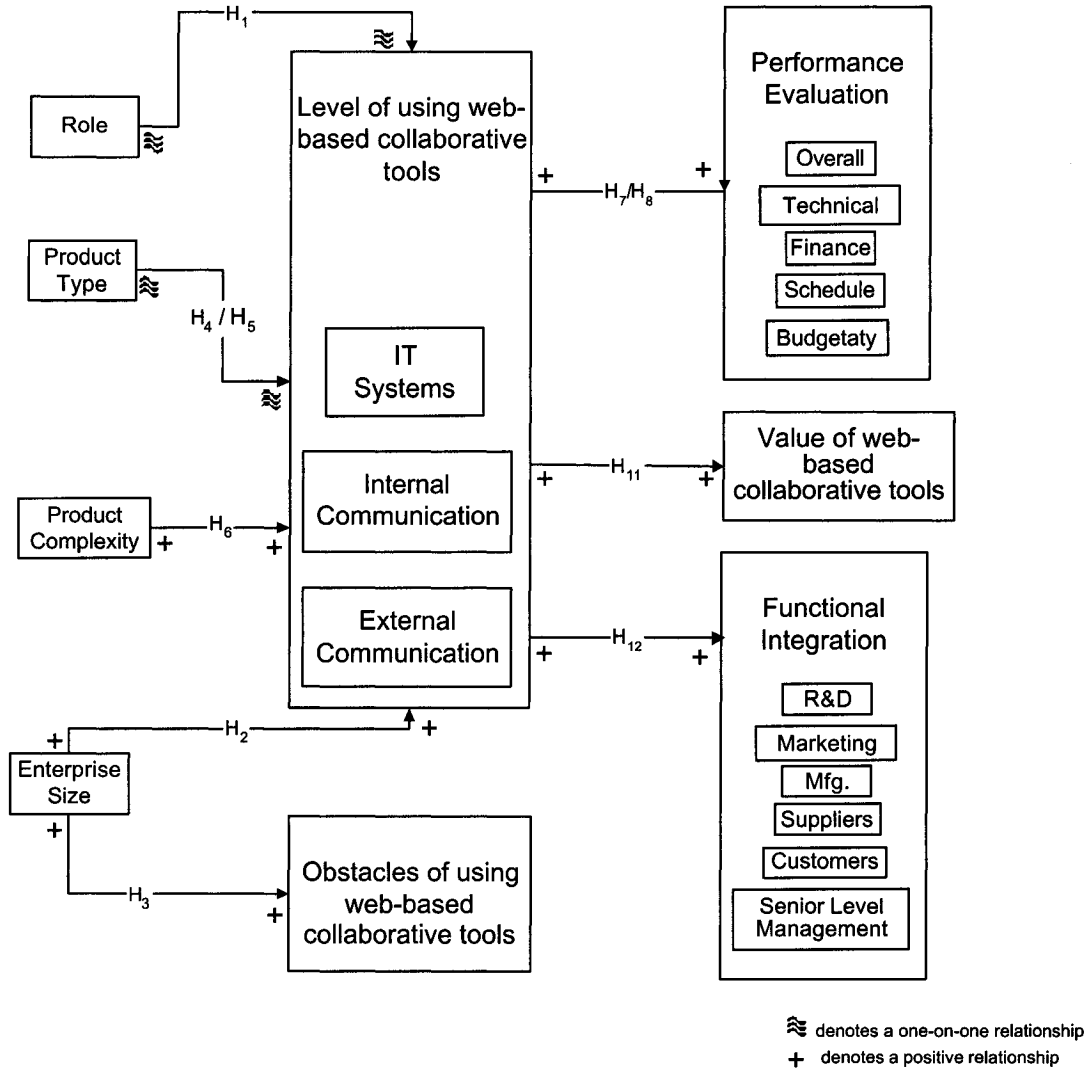


Figure 4: Variable relationships

Figure 4 presents the relationships among the variables examined in this study. The following four variables are the input variables: the role, the product type, the product complexity, and the size of the enterprise. Hypothesis 1, 4 and 5 assume the role of the respondent and the product type both have a one-on-one relationship with the level of using web-based collaborative tools; while hypothesis 2, 3 and 6 assume the product complexity and the size of the enterprise would contribution positive impacts to the use of web-based collaborative tools.

On the other hand, this research also examines the contribution of the use of web-based collaborative tools to the project performance and the level of functional integration. Hypothesis 7 and hypothesis 8 suggest that the use of web-based collaborative tools have positive impacts on the project performance. Hypothesis 12 assumes that the use of web-based collaborative tools will also contribute to the level of integration. In addition,

hypothesis 11 is intended to prove that the users who use intensive web-based collaborative tools would have positive feedback for the tools.

Chapter 4: Data Collection

4.1. Data inquiry method

Among several survey techniques, this research chose to conduct an on-line web survey through a 3rd party online survey provider, “*InsightExpress*”, for the following reasons:

1. Web-surveys have been proved as less expensive and less time consuming. In other words, a web-survey is more effective in this study.
2. *InsightExpress* offers guaranteed completed questionnaires; therefore, the responsibility of the return rates is entirely taken from researchers.
3. *InsightExpress* also provides basic web-based data descriptive tools. It makes data analysis easier and increases efficiency.
4. In addition, *InsightExpress* makes suggestions and gives advice with the content of the questionnaire for researchers.

However, like all other tools, web-survey has its advantages and disadvantages, especially when conducting a survey through a 3rd party partner. Aside from all the functionalities provided by *InsightExpress*, there are rules and limitations as well:

1. The number of questions in each survey is limited to 15 questions;
2. The maximum choices per question is 10 answers;
3. The maximum grid elements per survey are 20 elements;
4. No specific research quotas are allowed.

The target-completed questionnaires was a sample of 200. The sampling diagnostic will be introduced in the next section.

4.2. The Sampling Diagnostic

The sampling procedure of this research is considered as expert sampling, which requires individuals with acknowledged experience and insight into the software development field. The target subjects required by this survey are on-line users who currently work in the software industry and have experience working on new product development of software products. Since this survey was conducted through *InsightExpress* on line, the subjects were randomly drawn by one of their on-line sample panels. This research decides to require samples drawn from the panel “Business to business; Software/Computer

management”, based on *InsightExpress*’s “Job Function” categorization. There was no sample selection bias because the samples were previously randomly selected.

According to recruitment methodology provided by “*InsightExpress*”, their recruiting procedure is slightly different than most of their other counterparts in the market. The recruitment procedure is a two-way screening procedure, in contrast to a one-way opt-in by on-line users. First, *InsightExpress* reaches individuals from tens of thousands of Web sites by proactively soliciting participation in surveys using a wide array of invitation methods (i.e., hyperlinks, pop-ups, banners, e-mails, etc.) The on-line users will receive an invitation to a simple survey for background information. In the general background information survey, “*InsightExpress*” gathers information such as the individuals’ job titles, income, general interests in order to screen the individuals. “*InsightExpress*” then assigns the subjects to one of the surveys designed by their customers based on this kind of demographic information. Second, when the subjects receive the specific surveys matching their demographic information, they can decide whether to respond to the survey or rather to drop out at any time.

“*InsightExpress*” also claims that: “Research results can be considered reliable if two surveys fielded concurrently to the same audience yield the same results. Through our patent-pending technology and randomization procedures, *InsightExpress* surveys meet this criterion. In fact, all Research-On-Research initiatives have yielded no statistical differences at the 90% confidence level.”⁴

4.3. The Questionnaire

In this section, the explanation of each question in this questionnaire will be provided. As previously mentioned, the limitation of the number of questions by *InsightExpress* has somewhat restricted the design of this questionnaire. Hence, it is hard to perform cross validation on each variable. In this questionnaire, some variables could only be evaluated by one question. There are 15 questions in this questionnaire; however, question 1 is not really a question at all. Question 1 briefly introduced the purpose of this survey. Question 2 to question 7 and question 15 asks for general information about the specific software project that the individual has in mind. Question 8 to question 14 asks the individual about the use of collaborative tools they used for this project.

⁴ Recruitment methodology documentation provided by *InsightExpress*. See Appendix II *InsightExpress* recruitment methodology.

Question 1

Question 1 is not really a question at all. Rather, it identified the purpose of this survey, which is to investigate the influence of web-centric collaborative tools on the NPD process in the software development industry. The survey also required subjects picture a specific new product development process in their mind that they have participated in in the last six months. As a result of this requirement, individuals who have not participated in any NPD process in the last six months were screened out by the first formal question.

As well, the definition of “new product development” in this survey is also given in this statement.

Question 2:

What was your role for this specific new product development project?

The purpose of this question was to determine the individuals’ job function at the time of participating in the NPD process. Since this questionnaire requires subjects who are not only currently working in the software industry but also have experience participating in the NPD process as defined by the statement in question #1. It is important to screen out individuals who do not possess such experience. The possible answers to this question were: Managers (team leader/project manager/ general manager), software developer, testing engineer, manufacturing engineer, quality assurance, engineer, supplier, procurement, marketing / sales, customer, others and “there wasn’t a new product development project in the last six months”. Individuals who chose the last answer were immediately directed to the end of the survey. Thus, the survey was only taken by individuals who had recently participated in a new software product development process in the industry. The answer of this question was stored as “q2_role”, which is a nominal variable from 0 to 9, denoting team leader, software developer, testing engineer, manufacturing engineer, quality assurance engineer, supplier, procurement, marketing/sales, customer, and others respectively.

As a result of restricting survey takers to individuals who has participated in NPD projects within the last six months, the subjects had clear memories about the projects, and the data presents current market status instead of mixing up the current status with historical cases.

Question 3

How many employees currently work in your company?

One of the hypotheses of this research is that web-centric collaboration is positively related to the size of firms. Thus, the first step of proving this statement is to determine the size of the company that subjects work for. There are several ways to determine the size of a company, including the number of employees worldwide, annual revenue, market share and many more. Since the major aim of this research is to investigate the use of collaborative tools, the most important factor that needs to be taken into account is the “human” factor. Due to the limitation of the number of questions in this questionnaire, as mentioned previously, some variable could only be dealt with one question. Thus, this research takes the number of employees currently hired in the company as the factor to determine the size of this firm.

The number of employees has been divided into six sections, with “q3_size” variable as an ordinal variable. The six categories are: fewer than 50, 50 to 249, 250 to 499, 500 to 999, 1,000 to 2,500, and more than 2,500 (From 0 to 5).

Question 4

What type of new products are you delivering to the software industry? (Select at least one)

Prior to this project, no research had been done into the relationship between the use of collaborative tools and the kinds of products that are under development. However, the nature of the development process and collaborative degree vary among different types of software. For example, the software designed for internal use within a corporation will need to collaborate with internal users instead of external users. Moreover, the performance evaluation of products will be totally different for commercial products and in-house systems. Thus, it would be important to find potential relationship between the kinds of software projects and the collaborative techniques being used.

In this survey, the software projects delivered by participants were divided into six categories: business, firmware, military, shrink-wrap, system software and others. (McConnell, 1996) The questionnaire allows participants to chose more than one category. Each category is independent to each other; therefore, there are six variables in total. Each variable is a dichotomous variable that comprises 0 and -1 (-1 indicates Yes). The variables are: “q4_1_bus”, “q4_2_fir”, “q4_3_mil”, “q4_4_shr”, “q4_5_sys”, and “q4_6_oth”.

Question 5

Using the following scale, please indicate the level of technical complexity that was necessary to implement this new product. (Based on its major functional components)

Product complexity reflects the degree of the development difficulties of the NPD process. Intuitively, one of the first tasks for software project managers to handle a software project is to decompose it into smaller components. Basically, a software project can be decomposed from either a functional or design perspective. However, the method of decomposition may differ from one project to another, depending on the project manager's actual objective. A functional decomposition of a project divides the project into its basic components from a user's perspective, while a design decomposition divides a project into its basic programming components or modules. (Bennatan, 2000)

Again, due to the restriction of the number of questions, only one decomposition method is taken into account in this research. Here, the functional decomposition was chosen because it is easier to understand from the users' points of view. Hence, the complexity of a software project is determined by the number of the functional components of the product in this survey. It has been categorized into an interval variable from 1 to 7 (variable: "q5_cplx") denoting extremely simple (only one component) and extremely complex (more than seven components) respectively.

Question 6

Using the following scale, how much do you agree or disagree with each of the following statements?

This question is the first question to ask for project performance from the survey takers' point of view. The result of this kind of performance evaluation from the individual may fall into an arbitrary argument. Since it is hard to perform impersonal performance evaluations within limited questions and resources, however, the research can only rely on such perspectives.

There are four sub-statements including in this question:

- The project was a technical success relative to other projects of the company;
- The project was a financial success relative to other projects of the company;

- ❑ The project was completed within the budget relative to the initial objective;
- ❑ The project was completed on schedule relative to the initial objective.

These four sub-statements required individuals to evaluate this specific project from four perspectives: technical, financial, budgetary, and organizational (schedule) respectively. Each statement required individuals to judge the statement from degree 7 (strongly agree) to degree 1 (strongly disagree) or “don’t know”, if they do not know how to decide (code as 0 in row data). Therefore, question 6 contains four ordinal variables, including “nq6_1_tec”, “nq6_2_fin”, “nq6_3_bgt”, and “nq6_4_sch”.

This question was also the first multi-grid question to better exploit the maximum number of questions allowed. It virtually combined four questions into one. However, this kind of question is also labor intensive. Thus, grid questions need to be used carefully and limited the total number in one survey.

Question 7

Overall, how successful was the new product development project?

Question 7 is the second question to inquire about the project performance since performance evaluation is comparatively important to determine the use of collaborative tools and techniques. Instead of evaluating project performance from different angles, here, an overall performance of the project is required.

The variable “nq7ovral” is categorized into an ordinal variable of five degrees from “extremely successful (5)” to “not at all successful (1)”. Also, an option of “don’t know / not sure (0)” is also provided to alleviate the pressure on the user of making a decision. The format of this question has been tested in many standard surveys.

Question 8

For each of the following IT systems, please indicate whether the system is currently web based, planned to be web based or will not be web based?

Questions 8 to 14 inquired about the information related to collaborative tools and techniques. Since the major objective of this research is to investigate the use of web-based tools and techniques, the first step is to inquire about the current use of web-based IT systems. Question 8 thus requires users to provide web-based situations to fourteen IT systems. Certainly there are much more IT systems in existence. The fourteen IT systems listed here are considered as the most commonly used IT systems among software development companies and are the most significant for the NPD process. These systems include both horizontal collaboration with team members and vertical collaboration with customers and suppliers. Each system is categorized into three different web-based degrees: currently web-based, planned to be web based, and will not be web based. Again, an option “don’t know” for individuals who either were not familiar with such systems or do not know or were not sure about the current situation of such systems.

The fourteen IT systems and the variables representing each of them are listed following in Table 4. All of the variables are nominal variables from 3, 2, 1 to 0, denoting respectively: currently web based; not web based, but plan to be; will not be web based; and do not know.

Table 4: Variables of IT systems

	Name of the IT systems	Variables
1	ABC (Activity Based Costing)	nq8_1_abc
2	APS (Advanced Planning and scheduling)	nq8_2_aps
3	CSM (Component and Supplier Management)	nq8_3_csm
4	CIM (Computer Integrated Manufacturing)	nq8_4_cim
5	CRM (Customer Relationship Management)	nq8_5_crm
6	Data Warehousing	nq8_6_dw
7	Design Systems (CAD, CAM...etc)	nq8_7_ds
8	EDI (Electronic Data Interchange)	nq8_8_edi
9	ERP (Enterprise Resource Planning)	nq8_9_erp
10	MES (Manufacturing Execution Systems)	nq8_10_me
11	Order Management Configuration	nq8_11_om
12	PTS (Problem Tracking Systems)	nq8_12_pt
13	PDM (Product Data Management)	nq8_13_pd
14	WMS (Warehouse Management Systems)	nq8_14_wm

Question 9

*How often did you exchange project information **internally** (with other project team members) using the following techniques?*

This question investigates the current use of communication techniques. The communication techniques can be divided into three categories: non-web based, web-based asynchronous, and web-based synchronous. The collaborative functionality of these three categories varies a great deal in time and space (See Table 1: Different uses of collaborative systems classified in time and space). Therefore, it is beneficiary for this research to reveal, if any, different use of these three kinds of tools.

Non-web based communication techniques include: phone or fax and in-house conference meetings.

Web-based asynchronous communication techniques include: Electronic mail, bulletin boards, newsgroups, Intranet, and Extranet.

Web-based synchronous communication techniques include: Instant messaging and web-conferencing (audio/video).

However, in order to simply the question, the categorization is not mentioned in the questionnaire, but only the methods are listed as answers of this question. The last two components are commercialized product development software and customized product development software. These two items are packaged software with both asynchronous and synchronous components for licensed users.

A list of variables for communication methods used internally is found in Table 5. All of them are ordinal variables from 0 to 3, indicating “Never”, “Less than 5 times”, “6 to 10 times”, and “More than 10 times”:

Table 5: List of variables of communication methods used internally

	Name of the Communication methods	Variables
1	Phone / Fax	nq9_1_ph
2	In-house conference meeting	nq9_2_me
3	Electronic mail (also known as E-mail)	nq9_3_em
4	Bulletin Board	nq9_4_bu
5	Newsgroup	nq9_5new
6	Intranet	nq9_6int
7	Extranet	nq9_7ext
8	Instant messaging	nq9_8im
9	Web-conferencing	nq9_9web
10	Commercialized product development software	nq9_10co
11	Customized product development software	nq9_11cu

Question 10

*How often did you exchange project information **externally** (with customers / suppliers) using the following techniques?*

The answers of question 10 are identical to question 9. The difference between these two questions is the collaboration targets. Question 9 required the individual to confirm the use of communication methods with internal team members within the same organization whereas question 10 was with external customers or suppliers. Table 6 contains a list of variables for this question.

Table 6: Variables of communication methods used externally

	Name of the Communication methods	Variables
1	Phone / Fax	nq10_1ph
2	In-house conference meeting	nq10_2me
3	Electronic mail (also known as E-mail)	nq10_3em
4	Bulletin Board	nq10_4bu
5	Newsgroup	nq10_5ne
6	Intranet	nq10_6in
7	Extranet	nq10_7ex
8	Instant messaging	nq10_8im
9	Web-conferencing	nq10_9we
10	Commercialized product development software	nq1010co
11	Customized product development software	nq1011cu

Question 11

Based on the definition of “collaborative tools”, was there any web-based collaborative tool available for this project? If so, the web-based collaborative tool you will describe overall as:

Question 11 asked the individual about their general opinions on web-based collaborative tools, if there was one available for them to use at the time of developing this software project.

The answers have been divided into 5-point Likert rating scales and labeled as “extremely valuable (4)”, “valuable (3)”, “neither valuable nor not valuable (2)”, “not valuable (1)”, and “not at all valuable (0)” respectively. An option of “no web based collaborative tool

available for the project (-1)” was also provided for the individuals who did not have a web based collaborative tool to use at the moment. This variable, “q11value”, is an ordinal variable ranging from -1 to 4.

Question 12

Based on your experience, please identify the following benefits of collaborative product development tools.

The question intended to identify the benefits of collaborative product development tools from experienced users. Instead of an open question, here, the survey contained eleven common benefits collected from previous surveys related to NPD process for the individuals to choose from. However, individuals who have their own ideas can also choose the option “others” to specify their opinions. The 13 answers are:

- | | |
|--|---|
| <input type="checkbox"/> Enable automated source-code control; | <input type="checkbox"/> Reduce cost and waste; |
| <input type="checkbox"/> Enable 24/7 design; | <input type="checkbox"/> Reduced competition; |
| <input type="checkbox"/> Enable real-time communication; | <input type="checkbox"/> Reduced prices; |
| <input type="checkbox"/> Increase product innovation; | <input type="checkbox"/> Shortened product lifecycle; |
| <input type="checkbox"/> Increase process innovation; | <input type="checkbox"/> Others (please specify); |
| <input type="checkbox"/> Increased competition; | <input type="checkbox"/> None of these. |
| <input type="checkbox"/> Increased prices; | |

All thirteen variables are dichotomous variables that comprise 0 and -1 (-1 indicates Yes).

Question 13

Describe the purpose of the collaborative tools you used for this project (Check all that apply).

Again, a list of prepared components was listed for the individuals to choose from in this question instead of providing open space for the individuals to create their own answers. However, individuals who have their own ideas can also choose the option “others” to specify their opinions. Here, the individuals can have more than one answer for this question. The list of purposes includes the following:

- Exchange of project management information (timetables, project plans, costing...etc);

- Exchange of product related information (driver, user manual ...etc);
- Exchange of development documentation;
- Real-time communication with other team members;
- Response to sales orders;
- Place purchase orders;
- Management production information;
- Inventory control;
- Provide customer service;
- Others (please specify).

All of the answers are dichotomous variables that comprise 0 and -1 (-1 indicates Yes).

Question 14

Which of the following obstacles and resistances describe your web-based collaborative product development systems? (Select all that apply).

The purpose of question 14 was to determine the obstacles and resistances of the transformation of web-centric collaborative product development systems. Generally speaking, the obstacles can be separated into two categories: the first category is “non-technical difficulty” and the other is “technical difficulty”. “Non-technical difficulties” include:

- CPD increased IT expenses with lower return (reduction of product life cycle, cost savings);
- Failure to identify the proper balance between cost saving and the competition;
- Industry resistance to change;
- Lack of consensus between partners;
- OEM strategy for integrating product development processes with industry exchanges is still unclear;
- Inability for suppliers and customers to agree upon and implement the process standards;
- Crowded and complex CPD with hundreds of providers.

On the other hand, “technical difficulties” include the following:

- Difficulty to adapt existing legacy systems;
- Lack of web expertise;
- Non-compatible systems (wide adoption of incompatible systems);
- Security and desire to keep sensitive data within the boundaries of internal firewalls.

There are also some other technical challenges. Only the above will be included and discussed in this survey.

All twelve difficulty answers are dichotomous variables that comprise 0 and -1 (-1 indicates Yes).

Question 15

Using the following scale, please rate the degree of integration with each of the following departments during the entire development process:

Cross-functional integration refers to the level of unity of effort across functional areas in the developing and launching of a new product. The need of cross-functional integration to the NPD process has been stressed previously (Song and Parry, 1997.) Thus, question 15 intended to figure out the relationship between the use of collaborative product development tools and the degree of cross-functional integration.

Question 15 was also a grid question containing 6 sub-components. Each component was again divided into a 5-point rating scale plus an option of “don’t know”. The cross-functional integration is investigated here among six major functional groups, which in turn affects the proficiency of the NPD activities, such as product design and testing. The six functional groups are: R&D engineers, manufacturing sites, marketing and sales, suppliers, customers and senior level management.

List of variables for this question:

Table 7: Variables of integration

	Label	Name	Type
1	Integration: between R&D and manufacturing	q15_1	Ordinal
2	Integration: between R&D and marketing	q15_2	Ordinal
3	Integration: between manufacturing and marketing	q15_3	Ordinal
4	Integration: with suppliers	q15_4	Ordinal
5	Integration: with customers	q15_5	Ordinal
6	Involvement of senior level management	q15_6	Ordinal

Chapter 5: Data Analysis, Part I - Univariate Analysis

In this chapter, the results of the survey are presented based on a global variable point of view. Which is to say, a global variable is assigned to each question. Thus, the questionnaire yields 14 global variables, including the following:

Table 8: List of global variables

	Question #	Variable name	Description
1	Question 2	<i>g_role</i>	The <i>role</i> of the subject
2	Question 3	<i>g_size</i>	The <i>size</i> of the subject's company
3	Question 4	<i>g_type</i>	The <i>type</i> of software product delivered by the subject
4	Question 5	<i>g_complx</i>	The <i>complexity</i> of the software product
5	Question 6	<i>g_perform_elemnt</i>	Four aspects to <i>evaluate the performance</i> of the software project: technical, financial, budgetary, organizational (schedule)
6	Question 7	<i>g_ovral_perform</i>	The <i>overall performance</i> of the software project
7	Question 8	<i>g_web_lvl</i>	The <i>web-based level</i> of fourteen IT systems
8	Question 9	<i>g_intl_commu</i>	The frequency of using eleven <i>communication tools internally</i> among project team members
9	Question 10	<i>g_extl_commu</i>	The frequency of using eleven <i>communication tools externally</i> among project team members
10	Question 11	<i>g_value</i>	The <i>value</i> of web-based collaborative tools
11	Question 12	<i>g_benefit</i>	The <i>benefits</i> from using web-based collaborative tools
12	Question 13	<i>g_purpose</i>	The <i>purposes</i> of using web-based collaborative tools
13	Question 14	<i>g_obstacles</i>	The <i>obstacles</i> and difficulties of the diffusion of web-based collaborative tools
14	Question 15	<i>g_intgrt</i>	The level of the <i>integration</i> among the NPD organization

5.1. Sample Description

As previously described in chapter 4, questions 2 to 5 gathered the background information from the survey takers regarding to the role of the subject, the size of the company, the type of the product, and the complexity of that product. Further, question 6 and question 7 provide the information about project performance based on the survey respondents' viewpoints.

5.1.1. Role of the subject

Question 2: *What was your role for this specific new product development project?*

The results in Figure 5 show that 39.5% of the survey takers were team leaders and 32% were software developers.⁵ Therefore, team leaders (this term also include project managers and

⁵ See Appendix XIII for a list of "others".

general managers) and software developers constituted the majority of respondents of this survey. The data has shown that team leaders were most willing to participate in the research.

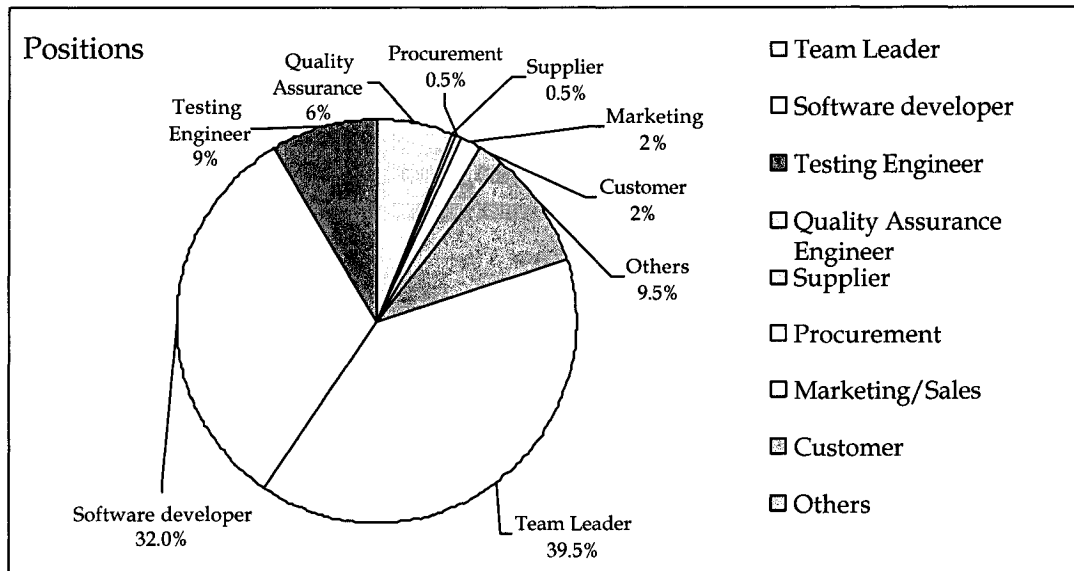


Figure 5: Composition of the positions of subjects

5.1.2. Size of the company

Question 3: How many employees currently work in your company?

The majority of the subjects fall into two very distinct categories: “More than 1,000” (37%) and “Fewer than 50” (22.5%). This composition can benefit the analysis later in this research about the effects of web-centric collaboration tools in very large corporations and small firms.

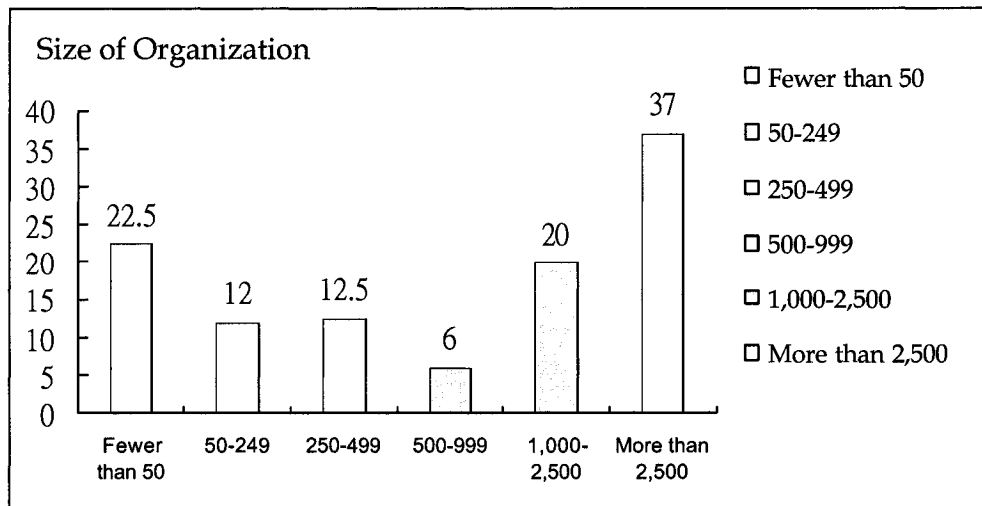


Figure 6: Subjects by organization size

5.1.3. Type of the software product

Question 4: *What type of new products are you delivering to the software industry? (Select at least one)*

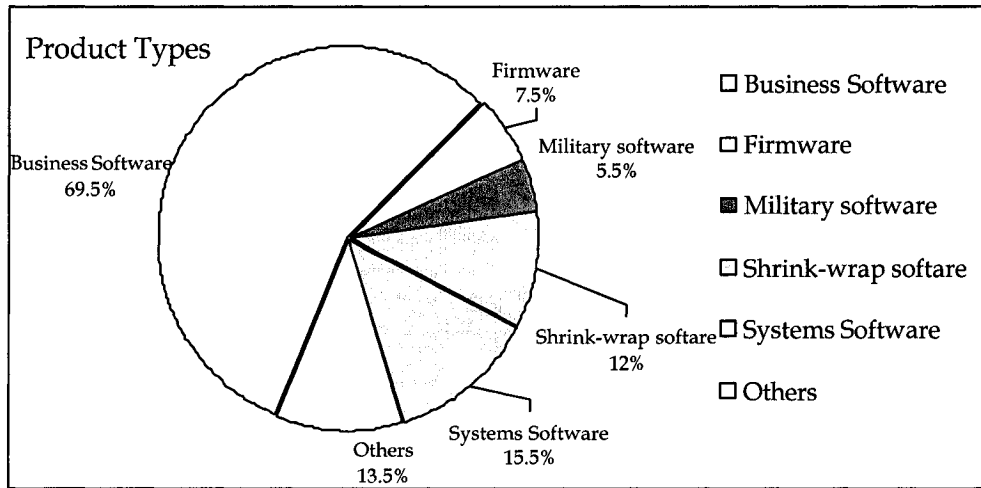


Figure 7: Subjects by types of products

As previously mentioned, this question had multiple selections. Therefore, subjects can be working on more than one type of software product at one time. The majority of the subjects (69.5%) responded that they are working on business software or in-house systems.⁶

5.1.4. Complexity of the product

Question 5: *Using the following scale, please indicate the level of technical complexity that was necessary to implement this new product. (Based on its major functional components)*

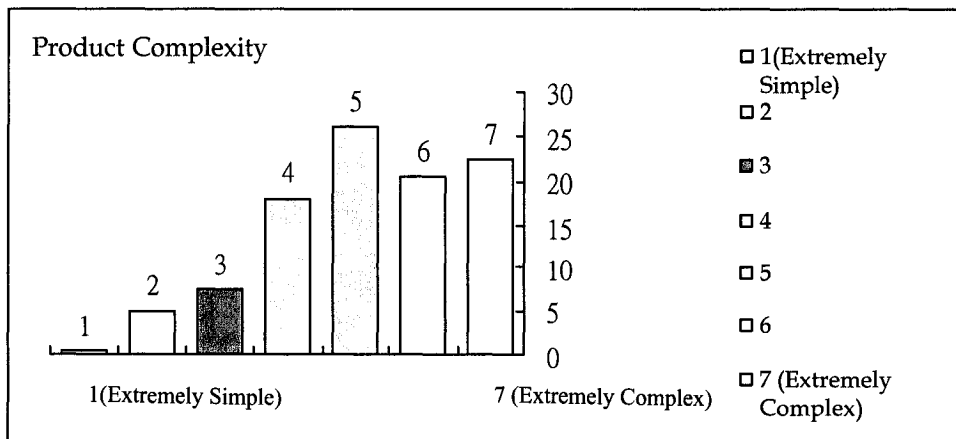


Figure 8: Results of product complexity

⁶ See Appendix XIII for a list of “others”.

In combining the percentage of subjects from mid-range level of complex products (from 4 to 6, 64.5% in total) and subjects from extremely complex products (22.5%), it can be concluded that the majority subjects of this survey were working on rather large projects. The result of large projects is preferable, since the larger the projects are, the greater communication is required.

5.1.5. Project performance evaluation by elements

Question 6: Using the following scale, how much do you agree or disagree with each of the following statements?

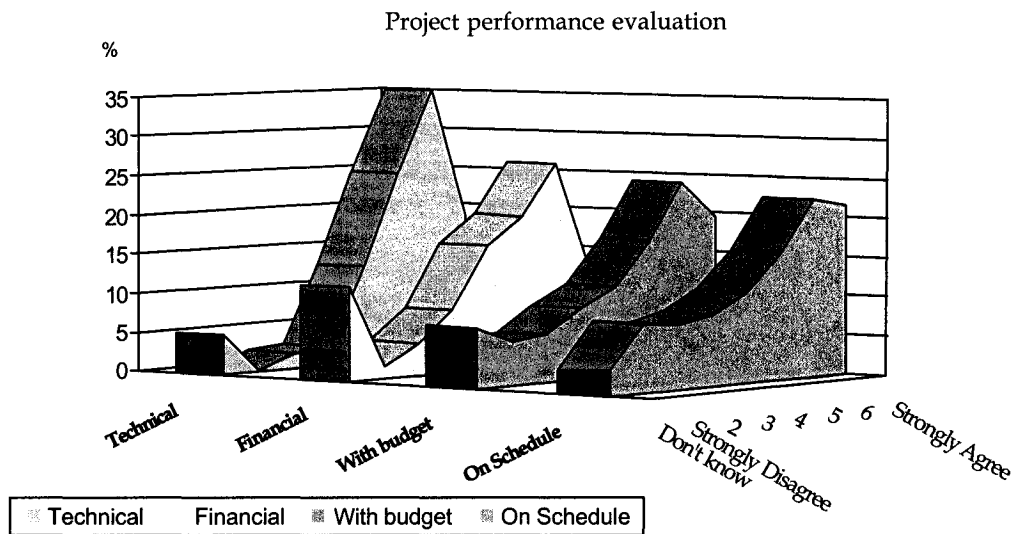


Figure 9: Results of project performance evaluation based on four perspectives

This question required subjects to evaluate their project performance from four different perspectives. The results show that most participants considered their projects as successful, especially from technical aspects (53.5% considered as successful or extremely successful).

Furthermore, a cluster analysis shows that to achieve success in one perspective, another perspective may have been compromised in some cases. Figure 10 and Figure 11 show the cluster analysis of these four evaluation elements. First, we divided the whole group into 2 clusters (Figure 10: Cluster analysis for performance evaluation elements: 2 clusters). As a result, 50 cases (cluster 2) declared medium technical success with low financial, budgetary and organization (schedule) satisfaction. As we further divided the whole group into 3 clusters (Figure 11: Cluster analysis for performance evaluation elements: 3 clusters), 27 medium technical success cases ended up with low financial, budgetary and organizational (schedule) satisfaction (cluster 2).

However, for most of the other cases (75% in 2 cluster analysis (Figure 10) and 52% in 3 cluster analysis (Figure 11)), the results show that respondents presented no conflict among the four performance elements. In other words, respondents consider all of the performance elements as equally successful.

Figure 10: Cluster analysis for performance evaluation elements: 2 clusters

	Cluster	
	1	2
Technical Success (rev)	6	4
Financial Success (rev)	5	2
Within Budget (REV)	5	2
On Schedule (REV)	6	2

Cluster	1	2
Valid	150.000	50.000
Missing	200.000	.000

Figure 11: Cluster analysis for performance evaluation elements: 3 clusters

	Cluster		
	1	2	3
Technical Success (rev)	5	3	6
Financial Success (rev)	5	1	5
Within Budget (REV)	4	1	6
On Schedule (REV)	3	2	6

Cluster	1	2	3
Valid	69.000	27.000	104.000
Missing	200.000	.000	.000

5.1.6. Overall project performance

Question 7: Overall, how successful was the new product development project?

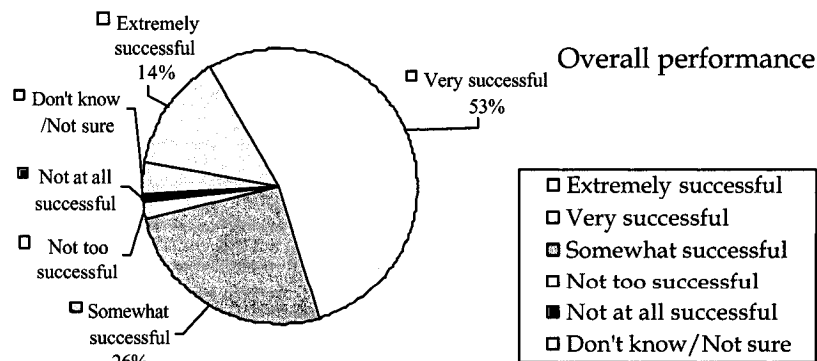


Figure 12: Results of overall performance

Over fifty percent of the participants described their projects as “very successful” (53.5%). Forty percent of others described their projects as either “extremely successful (14%)” or “somewhat successful (26%)” (similar to the results from the last question). Hence, only a very small portion

left (3%) of the participants did not consider the projects as successful. This might lead to an uneven sampling problem later when this variable was to be chosen for a dependant variable.

5.2. Use of the communication tools

5.2.1. Web-based level of IT systems

Question 8: For each of the following IT systems, please indicate whether the system is currently web based, planned to be web based or will not be web based?

Table 9: Web based status of 14 IT systems

Rank	Name of IT systems	Currently web based	Not web based but plan to be	Will not be web based	Don't know
1	Problem tracking systems (PTS)	35.5	24.5	18.5	21.5
2	Electronic data interchange (EDI)	29	21	23	27
3	Customer relationship management (CRM)	27	27	22	24
4	Product data management (PDM)	23	23.5	23.5	30
5	Order management configuration	22.5	20.5	21	36
6	Data warehousing	21.5	28	27	23.5
7	Enterprise resource planning (ERP)	18.5	22.5	28	31
8	Advanced planning and scheduling (APS)	17	26.5	28	28.5
9	Activity-based costing (ABC)	16.5	15	30.5	38
10	Component and supplier management (CSM)	11	21.5	31	36.5
11	Warehouse management systems (WMS)	11	20.5	27	41.5
12	Computer-integrated manufacturing (CIM)	7.5	12.5	35	45
13	Design systems (CAD, CAM, etc..)	7.5	12.5	41.5	38.5
14	Manufacturing execution systems (MES)	7.5	8.5	34	50
	Averages	18.21	20.29	27.86	33.64

(Row percent)

Generally speaking, the results show that the level of web-based in IT systems is currently still low (average: 18.21%). Problem tracking systems (PTS) ranks as the most currently web-based IT system, whereas Electronic Data Interchange (EDI) and Customer Relationship Management (CRM) follow as the second and the third popular web-based IT systems. In combining the result of “not web based, but plan to be” and “currently web-based”, it can be concluded that over 50 percent of these three IT systems are expected to be web-based in the near future. If compared to the top three “will-not-be-web-based” IT systems (CIM, Design systems and MES), one can intuitively observe that this may result from the different nature of the IT systems. In other words, if the users of the IT systems spread out over a large area, the web-based level increases. The top three non-web based IT systems are all used by either a single or independent department.

Moreover, on average about one third of the subjects did not know the current status of these IT systems. This result shows the lack of either information sharing or on-the-job training.

5.2.2. Internal use of communication tools

Question 9: *How often did you exchange project information internally (with other project team members) using the following techniques?*

Table 10: Internal use of communication methods

	Communication methods (%)	Never (0)	Less than 5 times (1)	6 to 10 times (2)	More than 10 times (3)	Mean
1	Electronic Mail (E-Mail)	2.0	4.5	5.5	88.0	2.80
2	Phone / Fax	6.5	24.0	16.0	53.5	2.17
3	In-House Conference Meeting	9.5	18.5	27.0	45.0	2.08
4	Intranet	31.5	13.5	12.0	43.0	1.66
5	Instant Messaging	57.0	14.0	5.5	23.5	0.96
6	Customized Product Development Software	59.5	14.5	7.5	18.5	0.85
7	Commercialized Product Development Software	64.0	12.5	7.5	16.0	0.76
8	Extranet	62.0	15.5	7.0	15.5	0.76
9	Web-Conferencing	62.5	16.0	8.0	13.5	0.73
10	Bulletin Board	69.0	18.0	2.5	10.5	0.55
11	Newsgroup	75.5	14.0	2.5	8.0	0.43

(Row percent)

The results show that email has gradually become one of the most popular communication tools that has taken the place of traditional means of communication (phone or face-to-face communication). Among all participants, 88% of them use e-mail to communicate to their internal team members more than 10 times during their new project development process. Only 2% of subjects never use e-mail to communicate with their internal team members.

The second most popular communication tools (used more than 10 times) are the phone or the fax machine (53.5%), in-house conference meetings (45%), and Intranet (43%). Obviously, e-mail has taken the place of traditional means of communication methods internally. However, the results still show that the use of synchronous communication tools, such as web-conferencing and instant messaging, is still not popular. Neither commercialized product development software nor customized product development software are so widely deployed by corporations. The top two least popular methods are bulletin boards and newsgroups. The common properties of these two tools (they are not point-to-point and are open to anyone with access to the tools) may have decreased the willingness from corporate users to use these tools for the project development process.

5.2.3. External use of communication tools

Question 10: *How often did you exchange project information **externally** (with customers / suppliers) using the following techniques?*

Table 11: External use of communication methods

	Communication methods (%)	Never (0)	Less than 5 times (1)	6 to 10 times (2)	More than 10 times (3)	Mean
1	Electronic Mail (e-mail)	24.0	8.5	9.5	58.0	2.01
2	Phone / Fax	23.0	20.5	13.5	43.0	1.77
3	Extranet	63.0	8.5	6.0	22.5	0.88
4	In-House conference meeting	42.5	25.0	14.0	18.5	1.09
5	Instant Messaging	76.0	8.0	4.0	12.0	0.52
6	Web-conferencing	73.0	11.5	4.0	11.5	0.54
7	Intranet	76.5	9.5	3.5	10.5	0.48
8	Commercialized Product development Software	77.0	8.0	6.0	9.0	0.47
9	Customized Product development Software	76.5	10.5	6.0	7.0	0.44
10	Newsgroup	82.0	8.5	3.5	6.0	0.34
11	Bulletin Board	81.5	10.0	3.0	5.5	0.33

(Row percent)

Table 11 shows similar results from Table 10 with minor differences. E-mail is still the most popular tool (58%), while the phone or the fax machine rank as the second (43%) and Extranet ranks as the third (22.5%) popular tool. However, the proportion of the use of e-mail of “more than 10 times” dropped dramatically from 88% to 58%, and subjects who never use e-mail to communicate increased dramatically from 2% to 24%. The reason of this phenomenon remains unclear in this study.

5.2.4. Value of web-based collaborative tools

Question 11: *Based on the definition of “collaborative tools”, was there any web-based collaborative tool available for this project? If so, the web-based collaborative tool you will describe overall as:*

As indicated in a glance of the current market (section: 2.4 Current market of collaborative software), the deployment of web-based collaborative tools is still in the early phase in the industry. Thus, it does not seem unexpected that there are about 40% of the subjects who did not possess web-based collaborative tools to use for their projects at the time.

Despite the subjects without access to web-based collaborative tools, a large proportion of the subjects with access to web based collaborative tools corresponded the tool as either “extremely valuable” or “valuable” (a sum up to 70.8%).

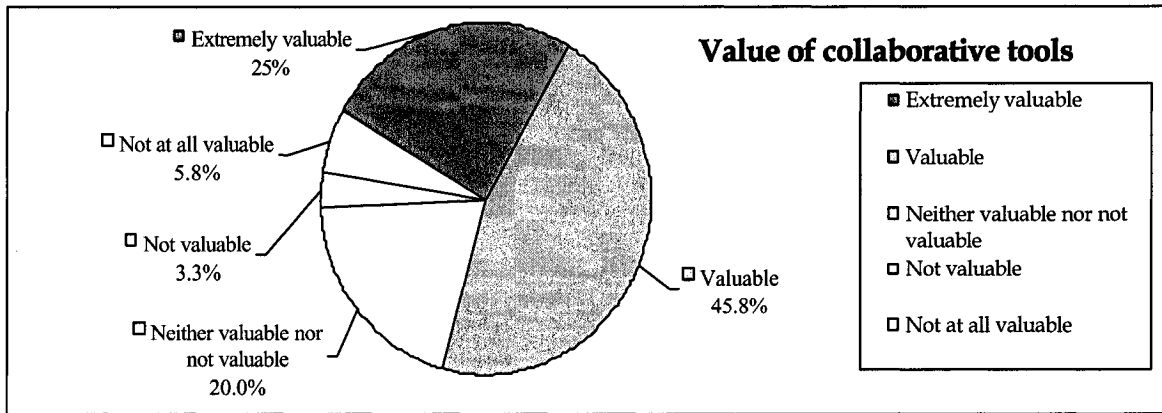


Figure 13: Results of the value of collaborative tools

5.2.5. Benefits of web-based collaborative tools

Question 12: Based on your experience, please identify the following benefits of collaborative product development tools.

Table 12: Results of benefits of collaborative tool

Rank	Benefits	Results (%)
1	Enable real-time communication	61.0
2	Reduce cost and waste	49.0
3	Enable automated source-code control	43.0
4	Enable 24/7 design	35.5
5	Shortened product lifecycle	32.0
6	Increase process innovation	27.0
7	Increase product innovation	25.5
8	None of these	16.5
9	Reduced prices	12.0
10	Increased competition	6.5
11	Increased prices	4.0
12	Reduced competition	3.0
13	Others	1.5

(Multiple-selection, total response: 635 responses from 200 subjects)

From the above table, 61% of the subjects considered the benefit of enabling real-time communication as the most important of the web-based collaborative tools. Further, 49% of the subjects considered that reducing cost and waste as an important benefit of web-based

collaborative tools. Evidently, the advantage of web-based collaborative tools has been proved as both time saving and cost reducing.

5.2.6. Purposes of using web-based collaborative tools

Question 13: *Describe the purpose of the collaborative tools you used for this project (Check all that apply).*

Table 13: Results of the purposes of collaborative product development tools

Rank	Purpose	Results (%)
1	Exchange of project management information (timetables, project plans, costing...etc.)	58.0
2	Real-time communication with other team members	46.5
3	Exchange of development documentation	46.0
4	Exchange of product related information (driver, user manual...etc.)	37.5
5	Provide customer service	22.0
6	Management production information	18.0
7	Others	16.5
8	Inventory control	8.0
9	Place purchase order	5.5
10	Response to sales order	4.5

(Multiple-selection, total response: 525 responses from 200 samples)

Overall, 58% of participants use collaborative tools to exchange project management information. This may have been a result from the majority of subjects being composed of team leaders (see Figure 5: Composition of the positions of subjects). Second, real-time communication shows up again on the top three of the purposes list. This proves as well that real-time communication has played an important role in the product development process.

5.2.7. Barriers of web-based collaborative tools

Question 14: *Which of the following obstacles and resistances describe your web-based collaborative product development systems? (Select all that apply).*

Table 14: Results of obstacles and resistances of web-based collaborative product development systems

Rank	Obstacles and resistances	Results (%)
1	Security and desire to keep sensitive data within the boundaries of internal firewalls	40.5
2	Difficulty to adapt existing legacy systems	30.0
3	Lack of web expertise	25.0
4	Lack of consensus between partners	23.5

5	Industry resistance to change	23.0
6	Non-compatible systems (wide adoption of incompatible systems)	21.5
7	Others	21.0
8	OEM strategy for integrating product development processes with industry exchanges is still unclear	13.5
9	Failure to identify the proper balance between cost saving and the competition	12.0
10	Inability for suppliers and customers to agree upon and implement the process standards	11.5
11	CPD increased IT expenses with lower return (reduction of product life cycle, cost savings)	5.0
12	Crowded and complex CPD with hundreds of providers	4.0

(Multiple-selection, total response: 461 responses from 200 samples)

As discussed before, the obstacles can be divided into two categories, “non-technical” and “technical” difficulties. The results show interestingly enough that most participants worried more about technical difficulties (the top 3 are all technical problems) that seem to be easier to overcome by technology advancement. However, this result is rather encouraging because once the technology evolution is underway, it is expected that more and more people will be willing to adapt to web-based collaborative tools.

Conversely, non-technical difficulties rank comparatively lower (4th, 5th, 8th, 9th, 10th, 11th, and 12th). However, since it seems harder to resolve non-technical difficulties, the result is quite positive for the technologists who cannot easily solve human errors.

5.3. Level of integration

Question 15: Using the following scale, please rate the degree of integration with each of the following departments during the entire development process:

The results (Figure 14) show the integration with customers is comparatively higher than between other groups. Senior level management involvement ranks as the second highest level of integration, which is a positive sign for the new product development process. However, the integration between manufacturing sites and marketing departments is quite low, which may result in troubles with the stability of the quality of production.

The level of integration is one of the most important dependant variables. This variable will later be used as a dependant variable when the effects of web-based communication tools on the level of the integration are evaluated.

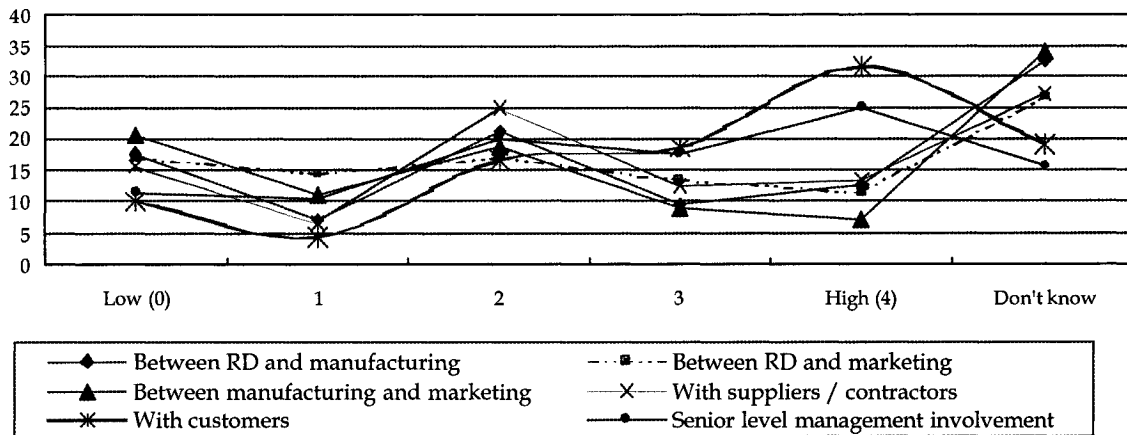


Figure 14: Results of integration between functional departments

Figure 15 and Figure 16 show the results of cluster analyses for the level of integration among the NPD process groups. When we first divided the subjects into 3 clusters (Figure 15), it was obvious that 35% (70 cases) of the subjects have an equally higher level of integration among all six groups (cluster 1). The subjects in cluster 2 have the lowest level of integration among all six groups; whereas the subjects in cluster 3 have a higher level of external integration and senior level involvement, but a rather lower level of integration between internal team members.

Figure 15: Cluster Analysis for integration level: 3 clusters

	Final Cluster Centers		
	1	2	3
Integration: RD and Manufacturing	3	0	0
Integration: RD and Marketing	3	0	1
Integration: Manufacturing and marketing	2	0	0
Integration- with Supplier	2	-1	2
Integration- with Customer	3	0	3
Senior Level Involvement	3	0	2

Number of Cases in each Cluster	
Cluster 1	70.000
Cluster 2	56.000
Cluster 3	74.000
Valid	200.000
Missing	.000

Figure 16 shows results similar to Figure 15. After having discovered the characteristics from the 3-cluster analysis, we further divided the subjects into four groups. In the latter, the results have also shown that 20% of the participants were not familiar with the integration level among their project team members (cluster 3). It is thus necessary to find out from this group of participants how the communication was conducted (will be discussed in bivariate analysis section in the next chapter).

Figure 16: Cluster Analysis for integration level: 4 clusters

Final Cluster Centers

	Cluster			
	1	2	3	4
Integration: RD and Manufacturing	2	0	-1	3
Integration: RD and Marketing	1	1	-1	3
Integration: Manufacturing and marketing	0	0	-1	2
Integration- with Supplier	0	2	-1	2
Integration- with Customer	1	3	-1	3
Senior Level Involvement	2	2	0	3

Number of Cases in each Cluster

Cluster	1	36.000
	2	57.000
	3	40.000
	4	67.000
Valid		200.000
Missing		.000

Chapter 6: Data Analysis, Part II - Bivariate Analysis

In this chapter, the results of the survey are discussed in more detail. The relationships between the subjects, the use of web-based communication tools, and the level of integration are cross-examined using cross-tabulations and chi-square tests for all local variables from each question. Moreover, several one-way ANOVA analyses have also been performed when the variables of cross-tabulations satisfied the restriction of ANOVA models.

Section Foreword:

- The cross-tabulation and chi-square analyses of this section are based on a correlation matrix (see: *Appendix IV: Correction matrix (ordinal by ordinal variables)*) and on a significance matrix (for nominal by nominal variables and nominal by ordinal variables) (see: *Appendix V: Significance matrix (nominal by nominal / ordinal variable)*).
- Cohen and Holliday (1982) suggested the following rules to determine the degree of correlation: 0.19 and below is very low; 0.20 to 0.39 is low; 0.40 to 0.69 is modest; 0.70 to 0.89 is high; and 0.90 to 1 is very high (Bryman and Cramer, 2001).
- To simply the problem, this section separate 93 variables into 14 global variables based on each question from the original questionnaire. The 14 global variables are: role, size, type of product, complexity, performance elements, overall performance, web-based level of IT systems, internal communication methods, external communication methods, the value of collaborative tools, the benefits of collaborative tools, the purposes of collaborative tools, obstacles and difficulties of collaborative tools, and the level of integration of the NPD organizations (see Table 8 for a list of global variables).
- As described in chapter 5, six questions gathered sample descriptions, seven questions measured the use of web-based communication tools, and one question measured the level of integration in the NPD process. For conceptual reasons, we cross examined all 93 local variables with two aspects:
 1. The relationship between the sample and the use of web-based communication tools.
 2. The relationship between the level of integration and the use of web-based communication tools.

Only significant relationships related to this research's objectives are reported.

6.1. Role of the subject ⁷

6.1.1. Role and internal use of communication tools

The ANOVA analyses show that software developers use less e-mail, bulletin boards, instant messengers, web conferencing, and customized product development systems than people in any other position. Figure 17 shows that the internal use of e-mail by software developers is lower than any other roles.

Multiple Comparisons

Dependent Variable: NQ9_3_EM
LSD

(I) Q2_ROLE	(J) Q2_ROLE	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Team Leader	Software Develop	.24*	.098	.017	.04	.43
	Testing Engineer	-.07	.156	.890	-.33	.29
	Quality Assurance	-.06	.181	.757	-.41	.30
	Others	-.14	.149	.351	-.43	.15
Software Developer	Team Leader	-.24*	.098	.017	-.43	-.04
	Testing Engineer	-.26	.159	.107	-.57	.06
	Quality Assurance	-.29	.183	.113	-.65	.07
	Others	-.38*	.152	.015	-.68	-.07
Testing Engineer	Team Leader	.02	.156	.890	-.29	.33
	Software Develop	.26	.159	.107	-.06	.57
	Quality Assurance	-.03	.220	.876	-.47	.40
	Others	-.12	.195	.546	-.50	.27
Quality Assurance	Team Leader	.06	.181	.757	-.30	.41
	Software Develop	.29	.183	.113	-.07	.65
	Testing Engineer	.03	.220	.876	-.40	.47
	Others	-.08	.215	.699	-.51	.34
Others	Team Leader	.14	.149	.351	-.15	.43
	Software Develop	.38*	.152	.015	.07	.68
	Testing Engineer	.12	.195	.546	-.27	.50
	Quality Assurance	.08	.215	.699	-.34	.51

*. The mean difference is significant at the .05 level.

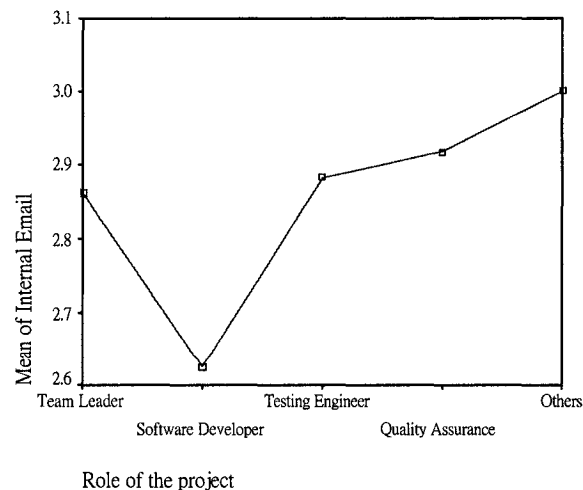


Figure 17: Role and internal use of e-mail

⁷ All of the ANOVA analyses in this section have eliminated categories such as “supplier (1)”, “procurement (1)”, “marketing or sales (3)”, and “customer (4)” due to the low presence of subjects. Further, normality and heterogeneity are tested prior to the ANOVA analyses.

6.1.2. Role and external use of communication tools

Similar results have been discovered for the relationship between the role of the project and the external use of communication tools. Both software developers and testing engineers use much less of the following tools externally than people in other project roles: bulletin boards, newsgroups, Intranet, instant messengers, web conferencing, and customized product development systems. Figure 18 shows one of the examples of this phenomenon.

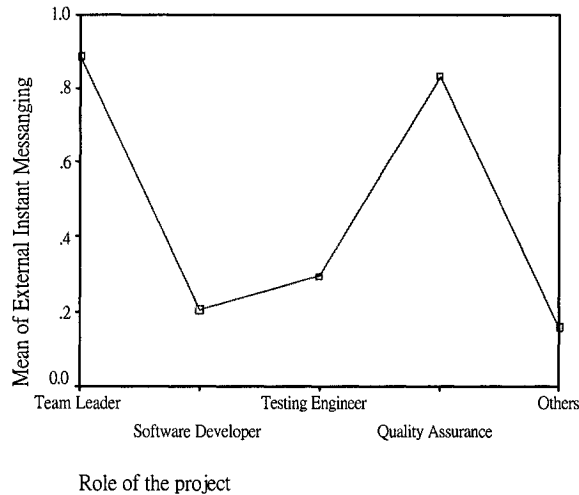


Figure 18: Role and external use of instant messaging

6.1.3. Role and value of the web-based collaborative tools

Figure 19 shows that the subjects of “quality assurance (QA)” have given the web-based collaborative tools the highest evaluation whereas software developers have given the lowest.

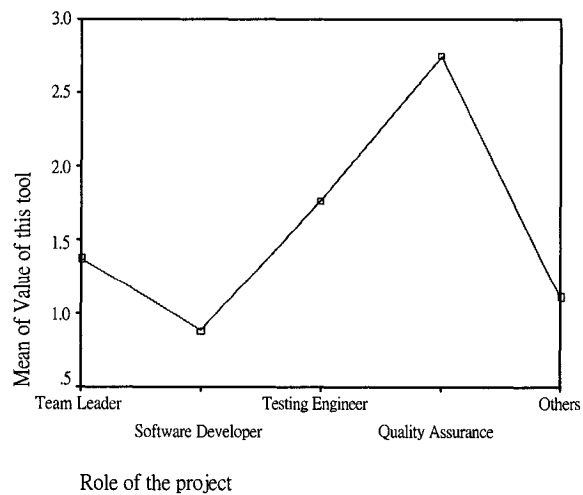


Figure 19: Role and value of the web-based CPD tools

6.1.4. Role and benefits of web-based collaborative tools

With the ANOVA model, three benefits have been evaluated as significant relationships with the variable “q_role” (the role of the project): “real-time communication”, “increased process innovation”, and “shortened product lifecycle”. Further analyzing in detail with contingency tables and bar charts, we found that QA has played an important role on this matter. With all three benefits, QA accounts for most of the proportion, especially with “real-time communication”. One hundred percent of the QA considered real-time communication as one of the important benefits of web-based collaborative tools.

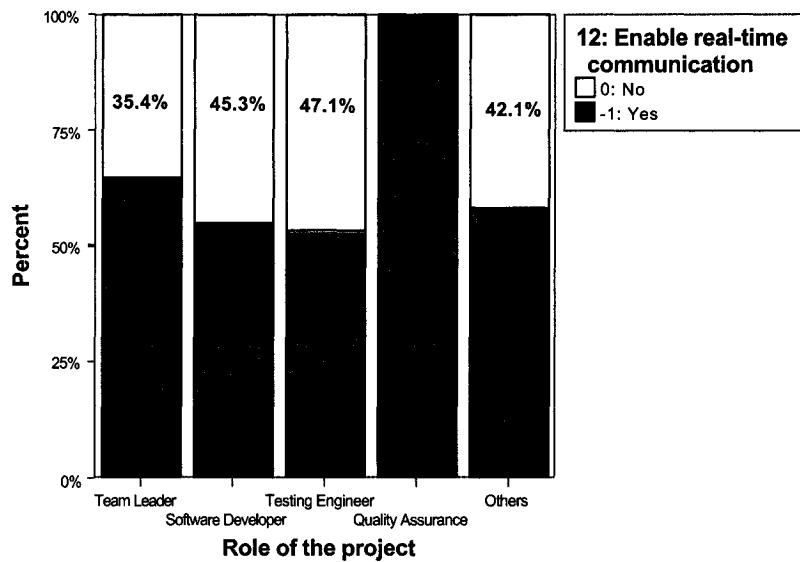


Figure 20: Role and benefits

6.1.5. Role and purposes of using web-based collaborative tools

Three purposes have been evaluated as significant relationships with regard to the role of the project: “exchange of product related information”, “place purchase orders”, and “inventory control”. We further diagnose these three purposes in the following paragraphs.

- Exchange of product related information (q13_2)

Cross-tabulation has revealed a positive relationship (Cramer’s V = 0.345) between the role of the project and the way they use web-centric collaborative tools to exchange product related information.

Table 15 somehow shows only a small portion of the software developers use web-based tools to exchange product related information.

Table 15: Role and purposes of using web-based collaborative tools

	Team Leader	Software Developer	Test Engineer	Quality Assurance
Use	45.6%	21.9%	47.1%	83.3%
Doesn't use	54.4%	78.1%	52.9%	16.7%

□ Place purchase orders (q13_6)

The relationship strength between the role and the purpose of placing purchase orders is positive (Cramer's V = 0.256). Figure 21 shows that only a small portion of project leaders and test engineers considered placing purchase orders as their purpose of using web-based collaborative tools.

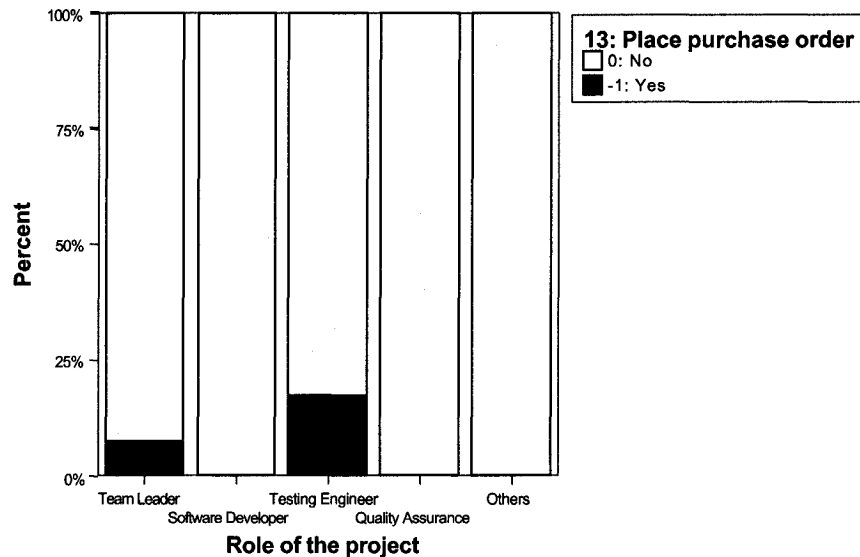


Figure 21: Role and purpose of placing purchase orders

□ Inventory control (q13_8)

The relationship strength between the role and the purpose of inventory control is positive as well (Cramer's V = 0.232). Based on Figure 22 (on the preceding page), only a comparatively larger proportion of QA (25%) use web-based collaborative tools to control the inventory.

Section conclusion

Overall, it is still hard to accept H_1 (that different roles use collaborative tools for different purposes) based the result since only three out of nine purposes have shown significant relationships. We can only conclude that H_1 is partially **accepted**.

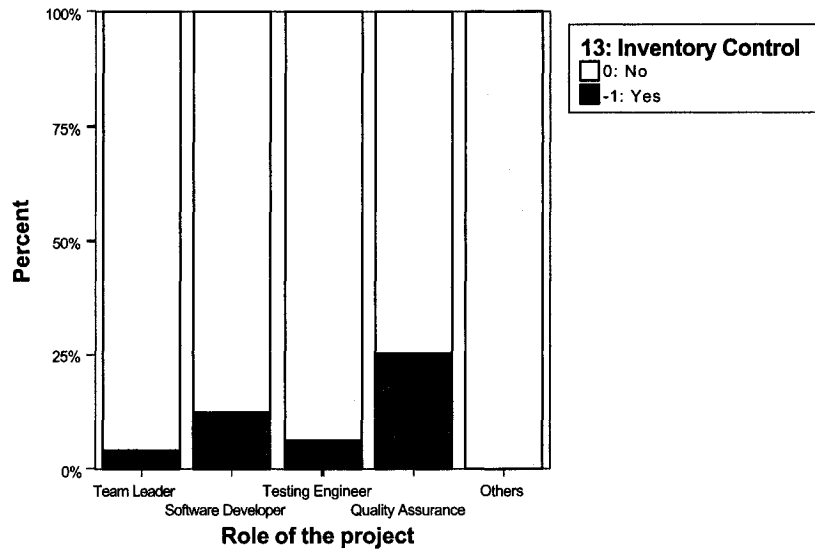


Figure 22: Role and purpose of inventory control

6.2. Size of company

6.2.1. Size of company and internal use of communication tools

In this category, only one significant relationship was found through cross-tabulation. Gamma(0.214) was found between the size of the company and the internal use of “in-house conference meeting”. A linear regression model has also proved the low degree of positive correlation (also called “low positive” in this study”). In other words, **the larger the company, the higher the average frequency of internal in-house conference meetings** (Figure 23). Conversely, the size of the company does not have any significant impact on the external use of any communication tools (see Figure 23 on the proceeding page).

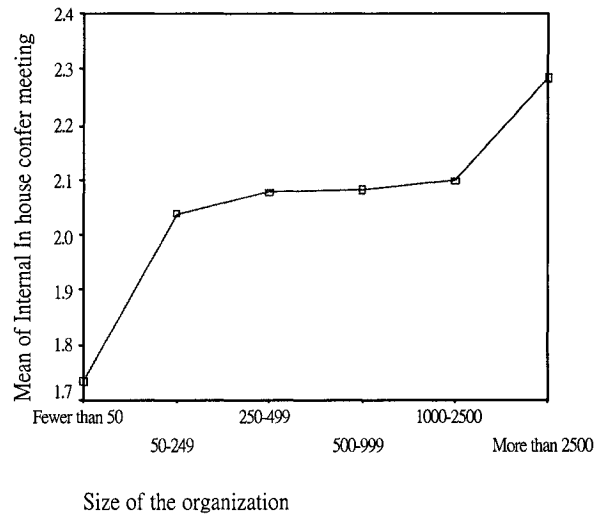


Figure 23: Size of the company and internal use of in-house conference meeting

6.2.2. Size of company and benefits of using web-based collaborative tools

One significant relationship has been found in this category. It is the positive (Cramer's $V = 0.281$) relationship between the size of the company and the benefit of increasing competition (q12_6). Figure 24 shows that, surprisingly, only medium-sized companies considered "increasing competition" as one of the benefits of using web-based collaborative tools.

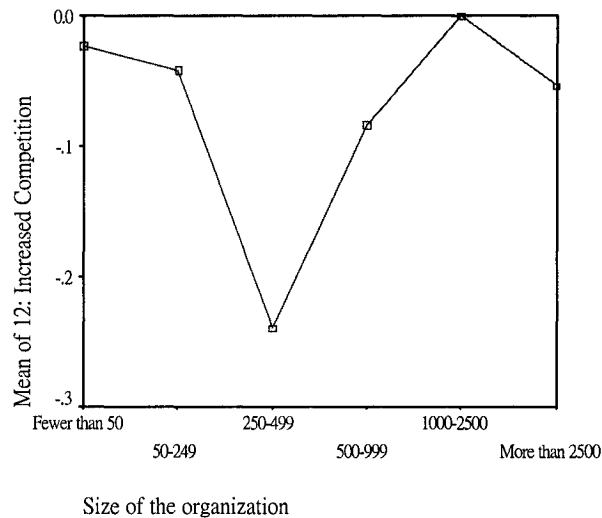


Figure 24: Size of company and benefit of increasing competition ⁸

⁸ The data in Figure 24 represents the average of the "code" number (0=NO, -1=Yes: answers for the original questions) from the subjects in each category. Therefore, the closer the data point to "0", the more the subjects answered "0" in the original row data.

6.2.3. Size of company and purposes of using web-based collaborative tools

One significant relationship has been found in this category. It is the positive (Cramer's $V = 0.2244$) relationship between the size of the company and the purpose of exchanging product related information (q13_2). Employees in small-sized (from 50 to 249 employees) and larger-sized (from 1000 to 2500) companies use collaborative tools to exchange product related information; while a large portion of employees in medium-sized companies (from 250 to 999) do not use collaborative tools to exchange product related information (see Figure 25).

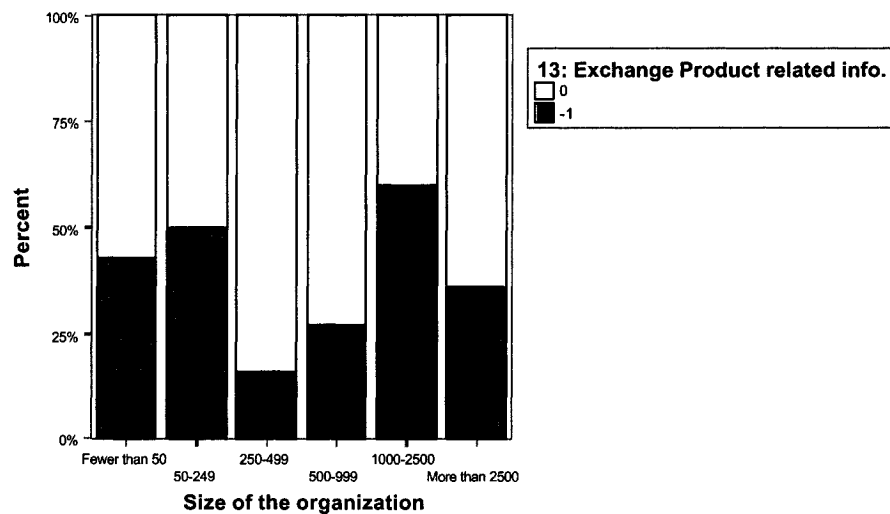


Figure 25: Size of company and purpose of "exchanging product related information"

6.2.4. Size of company and barriers of web-based collaborative tools

Two significant relationships have been found in this category. One is the positive (Cramer's $V = 0.270$) relationship between the size of the company and the barrier of "crowded and complex CPDs with hundreds of providers" (q14_3); the other is the positive (Cramer's $V = 0.260$) relationship between the size of the company and the barrier of "non-compatible systems" (q14_9). For the former case, the relationship only became significant because a great proportion of subjects did not agree that "crowded and complex CPDs with hundreds of providers" as one of the barriers. The latter case, however, shows that the larger the company, the more that agreed that "non-compatible systems" were barriers of web-based collaborative tools (see: Figure 26).

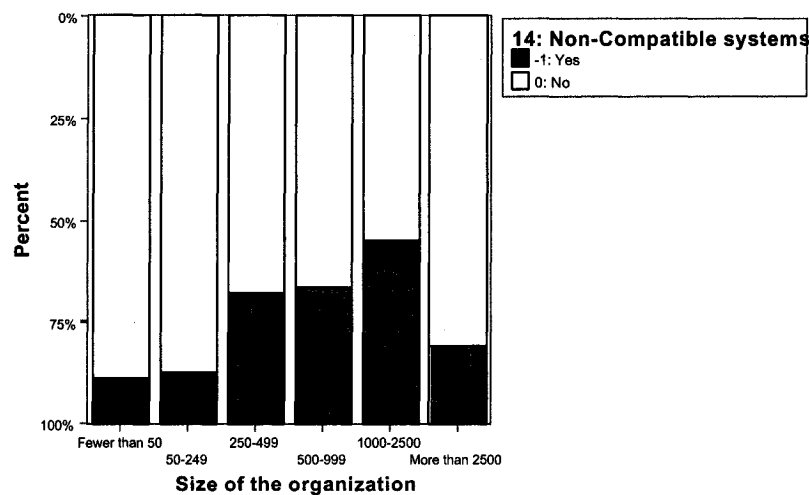


Figure 26: Size of company and barrier of "non-compatible systems"

6.2.5. Size of company and level of integration

A low degree of **negative** (also called "low negative" in this study) correlation (Gamma = -0.229) was found between the size of the company and the level of integration (between R&D and marketing)⁹. The results have shown that **the larger the company, the weaker the integration between R&D department and marketing department**, a finding which is quite logical. The question which arises here is whether the use of web-centric tools would help to resolve this problem.

Section conclusion

H₂ (that the web-based level of collaborative tools positively related to the size of the company) is **rejected** based on what we have discovered in this section. Neither the web-based level of IT systems nor the internal / external use of web-based communication tools have been found significant relationships by the size of the company. Conversely, only traditional means of communication tools, such as in-house conference meetings, are influenced by the size of the company.

H₃ (that the level of the difficulty to adapt web-based collaborative tools positively related to the size of the company) is **rejected** as well. Only one particular obstacle, the "non-compatible systems", was found as being influenced by the size of the company.

⁹ Since the subjects in category "do not know" accounts for a rather large proportion, the result has been tested twice. The first time we included the "do not know" category: Gamma = -0.141 (very low); the second time the "do not know" category was excluded: Gamma = 0.229 (low). Thus, the relationship was confirmed.

6.3. Type of product

Four categories of the product types are included in the discussion of this section. They are: business software (q4_1_bus), firmware (q4_2_fim), military software (q4_3_mil), shrink-wrap (q4_4_shr), systems software (q4_5_sys), and others (q4_6_oth).

6.3.1. Product type and web-based level of IT systems

We eliminated subjects in the category “do not know” if they account for a large proportion and retested the relationships again. Those significant relationships that disappeared in second testing will not be reported.

A “low positive” relationship (Gamma = .209) was found between “shrink-wrap software” and the Component and Supplier Management (CSM) systems (nq8_3csm).¹⁰ If the category “don’t know” was eliminated, 45.5% of the subjects who deliver shrink-wrap software already have web-based CSM systems. Over 70% of the CSM systems in this category will soon be web-based.

CSM Systems	Shrink-wrap software worker
Currently web based (WB)	45.5%
Not WB but plan to be	27.3%
Will not be web based	27.3%
Total:	100%

A “low positive” relationship (Gamma = .232) was found between “systems software” and the Advanced Planning and Scheduling (APS) systems (nq8_2_aps).¹¹ The following table shows over 50% of the subjects who are working on systems software will be using web-based APS systems in the near future.

APS Systems	Systems software worker
Currently web based (WB)	47.6%
Not WB but plan to be	9.5%
Will not be web based	42.9%
Total:	100%

¹⁰ Further Analysis: Gamma = .231 in the second test if the “do not know” category is excluded.

¹¹ Further Analysis: Gamma = .277 in the second test if the “do not know” category is excluded.

A “low positive” relationship ($\text{Gamma} = .222$) was found between “systems software” and the design system (nq8_7ds) (CAD, CAM...etc).¹² However, the following table shows rather different phenomena compared to the previously mentioned tables. It shows only about 33% of the subjects who are working on systems software will be using web-based design systems in the near future.

Design System	Systems software worker
Currently web based (WB)	28.6%
Not WB but plan to be	4.8%
Will not be web based	66.7%
Total:	100%

The results found in this section are correspondent to the significant relationship found in the previous section (the relationships between the role of the project and the use of web-based IT systems). Both results have revealed that the supporting roles (such as project managers) and tools (APS, CSM) in a software project have a higher tendency of using web-based collaborative tools than the development roles and tools.

6.3.2. Product type and internal use of communication tools

Two significant relationships are worthy of noting in this category. One is the relationship between “military software” and Extranet (nq9_7ext) ($\text{Cramer's } V = .205$); the other is the relationship between “firmware” and Extranet ($\text{Cramer's } V = .231$). Both cases have shown that the subjects who work on military software and firmware use more Extranet than the subjects who do not work on these two kinds of software. Figure 27 shows a larger proportion of the subjects who do not work on firmware (“never”), use Extranet for their projects.

¹² Further Analysis: $\text{Gamma} = .264$ in the second test if the “do not know” category is excluded.

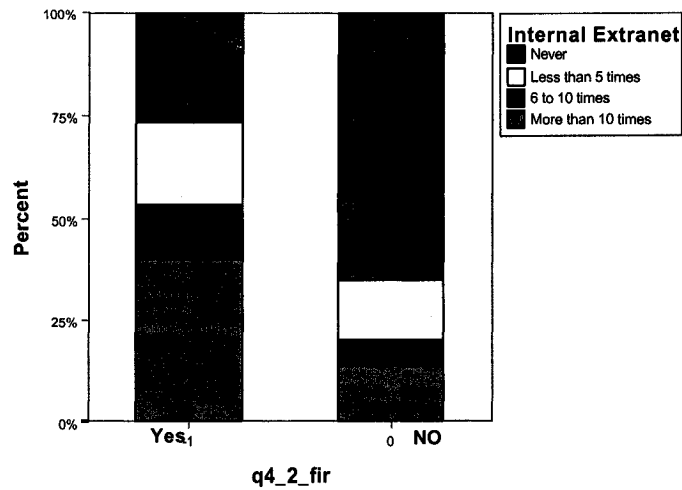


Figure 27: Firmware and use of Extranet

6.3.3. Product type and external use of communication tools

A number of significant relationships have been discovered in this category. Since there are a number of items, we will use the preceding table to illustrate each of them. All relationships are either “low positively” or “very low positively” (Gamma below 0.2) related.

Table 16: Significant relationships between product type and external use of communication tools

Communication tool	Related Product Type	Gamma
Phone or fax machine (nq10_1ph)	Systems Software	.242
In-house conference meeting (nq10_2me)	Military Software	.257
Email (nq10_3em)	Other Software	.198
Bulletin board (nq10_4bu)	Firmware	.208
Bulletin board (nq10_4bu)	Shrink-Wrap Software	.229
Extranet (nq10_7ex)	Firmware	.223
Extranet (nq10_7ex)	Systems Software	.246
Instant messaging (nq10_8im)	Firmware	.203
Web conferencing (nq10_9we)	Shrink-Wrap Software	.213
Web conferencing (nq10_9we)	Systems Software	.211
Commercialized PDS (nq10_10co)	Shrink-Wrap Software	.264
Commercialized PDS (nq10_10co)	Systems Software	.260
Customized PDS (nq10_11cu)	Firmware	.224
Customized PDS (nq10_11cu)	Shrink-Wrap Software	.212
Customized PDS (nq10_11cu)	Systems Software	.263

Most of the significant relationships in the above table (Table 16) are results from a large proportion of a distinct category. For example, 45.5% of military software participants hold external (with supplier or customers) in-house conference meetings more than ten times for their projects.

In comparison to the internal use of communication tools, the types of software products seems to influence a great deal more on the external use of communication tools. The categorization of product types in this study was based on the target market and the potential users. In other words, the target marketing and the consumer behavior have an indirect impact on the use of external communication.

Furthermore, as a comparison among each product type, the **communication between subjects who work on firmware seems to be greater than any other role**, whereas systems software ranks as the second. The following table shows the ranking of each software type related to the external use of communication tools.

Table 17: Ranking of the use of communication methods between different types of products

		Business Software	Firmware	Military Software	Shrink wrap	Systems Software	Others
Phone/fax	percentage	58.2	66.7	81.8	41.6	54.9	59.3
	rank	4	2	1	6	5	3
Conference meeting	percentage	32.4	46.7	81.9	37.5	35.5	33.3
	rank	6	2	1	3	4	5
E-mail	percentage	66.9	86.7	81.8	58.3	77.4	74.1
	rank	5	1	2	6	3	4
Bulletin Board	percentage	6.5	20.0	9.1	16.7	10.9	0
	rank	5	1	4	2	3	6
Newsgroup	percentage	8.6	20.0	9.1	27.0	19.6	0
	rank	5	2	4	1	3	6
Intranet	percentage	15.1	26.7	18.2	12.5	19.4	3.7
	rank	4	1	3	5	2	6
Extranet	percentage	27.4	46.7	45.5	29.1	48.4	40.7
	rank	6	2	3	5	1	4
Instant messaging	percentage	17.2	13.3	9.1	16.7	22.6	14.8
	rank	2	5	6	3	1	4
Web conferencing	percentage	17.2	26.6	9.1	8.4	19.3	11.1
	rank	3	1	5	6	2	4
Commercialized PD software	percentage	15.2	20.0	18.2	0	22.6	14.8
	rank	4	2	3	6	1	5
Customized PD software	percentage	14.4	20.0	27.3	0	29.0	7.4
	rank	4	3	2	6	1	5
Average Ranking		4.36	2	3.09	4.46	2.36	4.72

(Based on the total percentage of using the tool for "more than 10 times" and "6 to 10 times")

6.3.4. Product type and value of web-based collaborative tools

Value of the tool (q11 value) is “low positively” (Gamma = .270) related to shrink-wrap software. The following table (Table 18) shows the detail relationship found between the type of software product and the value of the web-based collaborative tool. 37.5% of the **shrink-wrap software** developers considered the value to be “extremely valuable”, which is the highest among all types of the products. In other words, shrink-wrap software workers have the highest satisfaction on collaborative tools.

Table 18: Product type and value of collaborative tools

(%)	Business	Firmware	Military	Shrink-wrap	System	Others
No web based tools available for the project	40.3	26.7	63.6	29.2	35.5	33.3
Not at all valuable	3.6	.0	.0	8.3	.0	3.7
Not valuable	2.2	.0	.0	.0	.0	3.7
Neither valuable nor not valuable	11.5	.0	.0	12.5	9.7	11.1
Valuable	28.1	46.7	18.2	12.5	32.3	40.7
Extremely Valuable	14.4	26.7	18.2	37.5	22.6	7.4
Total	69.5	7.5	5.5	12.0	15.5	13.5

Conversely, 63.6% of the military software developers do not have web-based collaborative tools available for use on the project. If we try to cross investigate this phenomenon with the obstacles and difficulties of the implementation of collaborative tools (question 14), 72.7% of military software developers consider “security and desire to keep sensitive data with the boundaries of internal firewalls” as the most important reason of the diffusion of web-based collaborative tools. The proportion is significantly higher than the average, which is 40.5%.

6.3.5. Product type and purpose of web-based collaborative tools

Each subject has a preferred function of varied types of collaborative tools based on purpose:

1. Business software: 51.8% of business software developers were in favor of “**Real-time communication**”(q13_4) as their primary purpose of using web-based collaborative tools (Cramer's V = 0.160, very “low positively” related).
2. Firmware: 66.7% of firmware software developers were in favor of “**Exchange product related information**”(q13_2) as their primary purpose of using web-based collaborative tools (Cramer's V = 0.172, very “low positively” related).
3. Military software: a large proportion (91.9%) of military software developers did not consider “**Real-time communication**”(q13_4) as one of the purposes of using web-based collaborative tools (Cramer's V = 0.181).

6.3.6. Product type and level of integration

Only the integration between manufacturing sites and marketing departments has relationships with firmware, system software and “others” software.

1. Firmware: (Cramer's $V = 0.280$, “low positively” related) subjects that work on firmware have a comparatively higher integration between manufacturing sites and marketing departments.
2. System software: (Cramer's $V = 0.263$, “low positively” related) subjects that work on systems software also have a comparatively higher integration between manufacturing sites and marketing departments.

Section conclusion

H₄ (that the subjects who develop different types of software products use different web-based IT systems) is **accepted** based on what we have learned in section 6.3.1. For instance, the web-based level of CSM systems for the subjects who work on shrink-wrap software (45.5%) is a great deal higher than the proportion of the whole sample (11%). Thus, “product type” does have impact on the web-based level of IT systems.

H₅ (that the subjects who develop different types of software products use collaborative tools for different purposes) is also **accepted** based on the results discovered in section 6.3.5. For instance, only a very small portion of the subjects who work on “military software” (8.1%) considered “real-time communication with other team members” as one of the purposes of web-based collaborative tools, while the percentage among all subjects is 46.5%.

6.4. Complexity of product

Unexpectedly, it appears that the complexity of the product (q5_cplx) does not have many significant relationships with other variables. Only seven significant relationship cells were found in the significance matrix (see *Appendix V: Significance matrix (nominal by nominal / ordinal variable)*). Apparently, the complexity of the product only related to three global variables: Performance elements (budgetary), IT systems (PTS systems), and internal communication tools (phone or fax, e-mail, Intranet, and customized PDS).

6.4.1. Product complexity and performance elements (budgetary)

A “very low negative” relationship ($\text{Gamma} = - 0.183$) was found between the variable “q6_3_bud” (within budget) and the complexity of the product (q5_cplx). Figure 28 shows the regression model between the product complexity and the budgetary performance. It indicates that the more complex the product, the lower the level of budgetary performance satisfaction, which is a logical reality. Normally, when a project become more complicated, it is harder to control the budget.

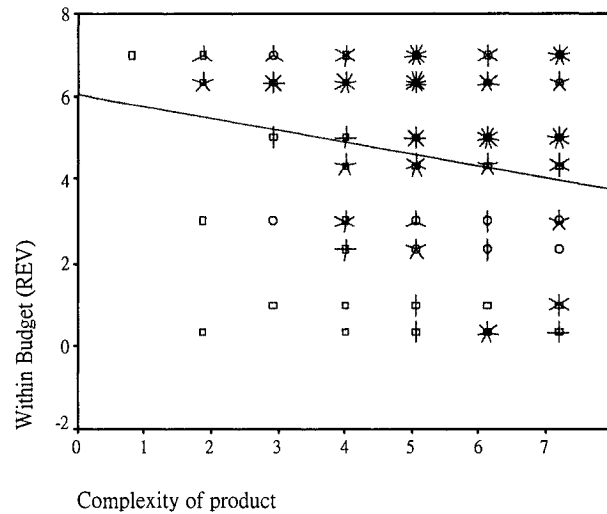


Figure 28: Scatter plot of product complexity and level of budgetary resource allocation

6.4.2. Product complexity and web-based level of IT systems

Cramer's V from 0.253 to 0.269, (if there is the exclusion of people who do not know anything about PTS, “low positively” related) was found between the product complexity and the web-based level of PTS systems.

As the level of product complexity increases, the web-based level of PTS systems increases as well. One of the hypotheses (H_6) assumes the more complex the software products, the higher the level of web based collaborative tool. In this case, H_6 is accepted on the PTS system in particular.

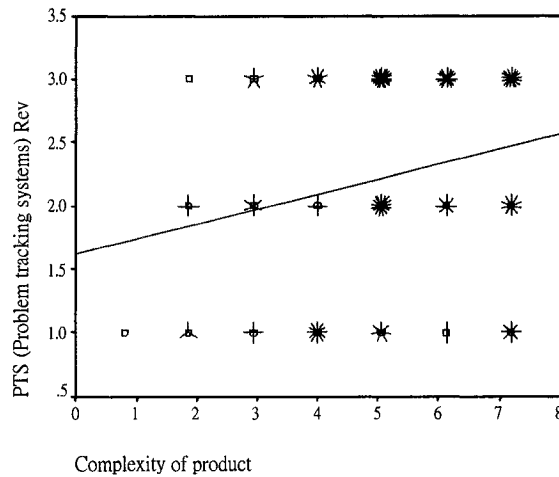


Figure 29: Scatter plot of product complexity and the web-based level of PTS systems

6.4.3. Product complexity and internal use of communication tools

In this category, four communication tools were found significantly related to the complexity of the products:

- 1) Phone or fax machine: (Spearman Correlation = 0.149) the internal use of a phone or a fax machine is very “low positively” related to the product complexity. **The more complex the product, the higher the internal use of a phone or a fax machine.** The proportion of the subjects who used a phone or a fax machine to communicate more than ten times increases from 30% to 64.4% as the complexity of product increases.
- 2) E-mail: (Spearman Correlation = 0.216), the internal use of email is “low positively” related to the product complexity. **The more complex the product, the higher the internal use of e-mail.** The proportion of the subjects who used email to communicate more than ten times increases from 60% to 97.8% as the complexity of product increases.
- 3) Intranet: (Spearman Correlation = 0.174), the internal use of Intranet is very “low positively” related to the product complexity. **The more complex the product, the higher the internal use of Intranet.** The proportion of the subjects who used Intranet to communicate more than ten times increases from 20% to 55.6% as the complexity of product increases.
- 4) Customized PDS: (Spearman Correlation = 0.165), the internal use of customized PDS is very “low positively” related to product complexity. **The more complex the product, the higher the internal use of customized PDS.** The proportion of the subjects who used customized PDS to communicate more than ten times increases from 13.3% to 33.3% as the complexity of product increases.

Here it is worthy of noting that the more complex the product, the higher the use of customized PDS since the use of customized PDS is quite low in general (only 18.5% used more than ten

times with all participants). The higher proportion of people using customized PDS with complex products indicates a potential market of customized PDS for the companies that produce more complex software products.

Section conclusion

H₆ (that the more complex the software products, the higher the use of web-centric collaborative tools) is **partially accepted** based on what we have discovered in section 6.4.2 and 6.4.3. In section 6.4.2, only one out of 14 IT systems has been found having a significant relationship with the product complexity. Moreover, in section 6.4.3, we also found that only the internal use of communication tools is significantly related to the complexity of the product. No significant relationship has been found between the external use of communication and the product complexity.

6.5. Performance elements

Four performance elements have been investigated in this section: technical (nq6_1tec), financial (nq6_2fin), budgetary (nq6_3bgt), and organizational (schedule) (nq6_4sch). These four performance elements will be tested as dependant variables while the others will be independent variables.

6.5.1. Performance elements and web-based level of IT systems

Initially, there were 16 cells of significant relationships found between the performance elements and the level of web-based IT systems. However, after eliminating the subjects who do not know or were not sure about the use of each IT system, all 16 of the significant relationships disappeared. As previously mentioned, on average over one third of the subjects (33.64%, see Table 9: Web based status of 14 IT systems) were not familiar with these IT systems. This factor may have caused the vague relationships. Therefore, we conclude that **there is no actual significant relationship between the use of web-based IT systems and the four performance elements.**

6.5.2. Performance elements and value of web-based collaborative tools

Among four performance elements, initially, only the level of financial success shows a significant relationship to the value of web-based collaborative tools (very “low positively”, Spearman Correlation = 0.142). However, if disregarding 40% of the participants who did not

have access to web-based collaborative tools for their projects at the time (See 5.2.4 Value of web-based collaborative tools), the level of technical success turns out to be the only variable that related to the value of web-based collaborative tools (“low positive”, Spearman Correlation = 0.222). The results show that the subjects with a higher level of technical success also consider web-based collaborative tools more valuable. Both budgetary and organizational (schedule) factors have comparatively less influence on the value of collaborative tools.

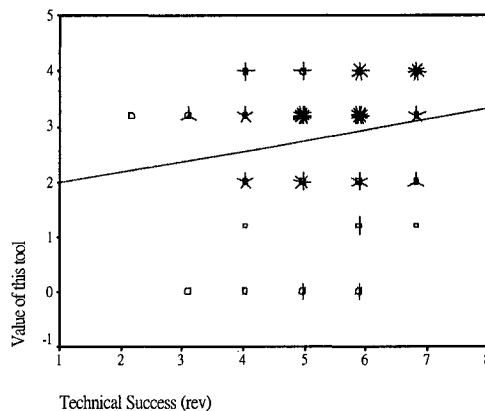


Figure 30: Technical success and value of web-based collaborative tools

6.5.3. Performance elements and benefits of web-based collaborative tools

Four significant relationships were found between the performance elements and the benefits of web-based collaborative tools.

1. The level of financial success is related to the benefit of “increase product innovation” (“low positive”, Cramer's V=0.319).
2. The level of technical success is related to the benefit of “increased prices” (“low positive”, Cramer's V=0.357), and “reduced cost and waste” (“low positive”, Cramer's V=0.260).
3. The level of satisfaction on schedule is related to the benefit of “shortened product lifecycle” (“low positive”, Cramer's V=0.269)

Here we can conclude that performance measurement factors do provide insight for the subjects to consider certain benefits of web-based collaborative tools. For instance, higher levels of delivering products on time (schedule factor) lead participants to consider “shortened product lifecycle” as the benefit of web-based collaborative tools.

6.5.4. Performance elements and level of integration

Only one significant relationship was found between the performance elements and the level of integration between NPD organizations: **the higher the level of integration between manufacturing sites and marketing departments, the higher the level of financial success** (very “low positive”, Spearman Correlation=0.188). However, this phenomenon is outside the boundary of this study.

Section conclusion

H₇ (that the project performance elements are positively related to the use of web-centric collaborative tools) is **rejected** based on what we have discovered in section 6.5.1. Neither the web-based level of IT systems nor the internal / external use of web-based communication tools have found significant relationships with the performance elements.

6.6. Overall Performance

Again, surprisingly, overall performance (q7_ovral) is not very relevant to other global variables. Only four cells of statistically significant relationships were found between the overall performance and the benefits of web-based collaborative tools; and between the overall performance and the barriers of web-based collaborative tools. The relationships do not seem to make any contribution to the interest of this research. Therefore, these relationships will be disregarded. We conclude that no single variable has a significant relationship or contribution to the overall performance. However, considering the importance of finding out the factors that influence the overall project performance, we will later use factor analyses to determine the effects of web-based collaborative tools on the overall project performance.

Section conclusion

H₈ (the overall project performance is positively related to the use of web-centric collaborative tools) is **rejected** based on what we have learned in this section. No single variable was found to be connected to the overall performance.

6.7. Web-based level of IT systems

This global variable is highly relevant to several global variables. The top three most related and most important global variables are: **other IT systems, external use of communication tools, value of web-based collaborative tools, and level of integration.**

6.7.1. Web-based level among IT systems

Here, all fourteen IT systems investigated in this research are 100% related to each other. In other words, **the web-based level of any particular IT systems is strongly related to the web-based level of any other IT systems.** For example, Figure 31 shows that the higher web-based level of the ABC (Activity Based Costing) system, the higher web-based level of the APS (Advanced Planning and Scheduling) system, and vice versa. The relationship is moderately positive with Cramer's V equal to 0.532.

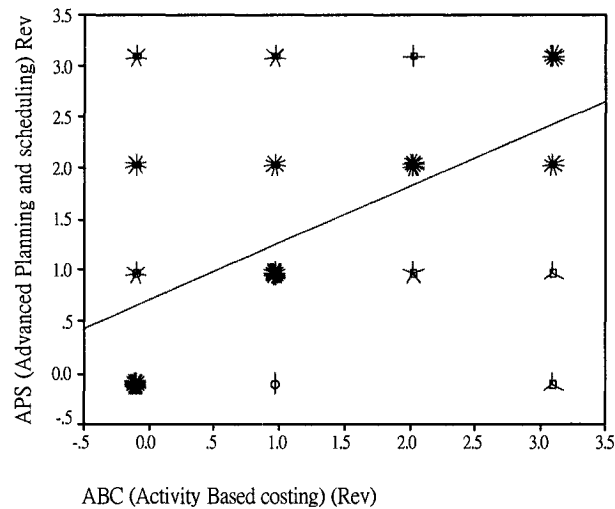


Figure 31: The scatter plot of ABC and APS

Since the web-based levels of these IT systems interact with one another, evidently, if one company is superior in any one of the IT systems in terms of the web-based level, it would be superior in all other IT systems. In other word, the technology gap has separated the advanced companies and the “lower technological” companies into two distinctive sectors. Thus, the stronger gets the stronger. Table 19 shows that the 68.4% of the subjects who are not familiar with ABC are also not familiar with APS; while at the same time, 48.5% of the subjects who currently have web-based ABC also have web-based APS.

Please refer to *Appendix VI: Cramer's V matrix among fourteen IT systems* for detailed relationships among fourteen IT systems. It is important to note that there is a greater correlation between the various IT systems' web-based levels than for any other variable being investigated. In other words, each of the IT systems is modestly positive related to any other IT system.

Table 19: Contingency table: ABC vs. APS

NQ8_2APS * NQ8_1ABC Crosstabulation

			NQ8_1ABC				Total
			Don't know	Will not be web based	Not Web but plan to be	Currently web based	
NQ8_2APS	Don't know	Count % within NQ8_1ABC	52 68.4%	2 3.3%		3 9.1%	57 28.5%
	Will not be web based	Count % within NQ8_1ABC	7 9.2%	41 67.2%	5 16.7%	3 9.1%	56 28.0%
	Not Web but plan to be	Count % within NQ8_1ABC	10 13.2%	11 18.0%	21 70.0%	11 33.3%	53 26.5%
	Currently web based	Count % within NQ8_1ABC	7 9.2%	7 11.5%	4 13.3%	16 48.5%	34 17.0%
Total		Count % within NQ8_1ABC	76 100.0%	61 100.0%	30 100.0%	33 100.0%	200 100.0%

6.7.2. Web-based level of IT systems and internal / external use of communication tools

133 out of 154 (86%) the cells composed by IT systems and the external use of communication methods were found to be statistically significant. In spite of the bias caused by the fact that some subjects were without knowledge or access to certain IT systems, this statistical significance still shows that the two global variables interact to a certain degree. Since all the relationships are positive, it shows that **the higher the web-based level of IT systems, the higher the frequency of external communication.**

Conversely, the significant relationships were only found in 42% (65 out of 154) of the cells composed by IT systems and the internal use of communication tools. Therefore, we can conclude that the web-based level of IT systems has a higher impact on the use of external use of communication tools than the internal use of communication tools.

6.7.3. Web-based level of IT systems and value of web-based collaborative tools

Out of the fourteen IT systems, only three IT systems have no significant relationship with the value of web-based collaborative tools. They are: data warehousing, design systems, and manufacturing execution systems (MES).

Except data warehousing systems, MES systems rank as the lowest web-based IT systems among the fourteen IT systems investigated, whereas design systems rank as the second lowest web-based IT systems (see Table 9: Web based status of 14 IT systems). Moreover, a large proportion of the subjects possessed no knowledge of the current status of their MES (50%) systems and design systems (38.5%). The results show that the web-based level of IT systems is impacting on the value of web-based collaborative tools. Therefore, we can conclude that **the**

higher the web-based level of IT systems, the higher the value of web-based collaborative tools. In other words, the subjects who have access to web-based IT systems have also identified the value of collaborative tools. Figure 32 shows the positive relationship between the web-based level of EDI systems and the value of web-based collaborative tools.

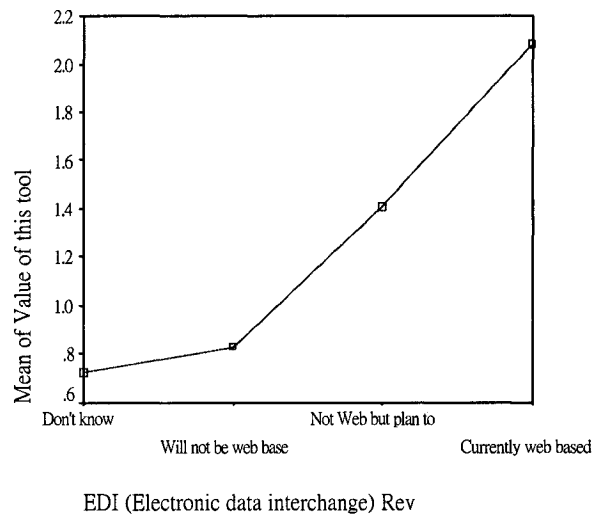


Figure 32: Web-based level of IT systems and value of web-based tools

6.7.4. Web-based level of IT systems and level of integration

Only two out of 84 cells are **not** significantly related. In other words, 97.6% of the bivariate tests ended up with significant relationships. Therefore, the level of web-based IT system does have an impact on the level of integration among different departments. Figure 33 shows the positive relationship between the web-based level of MES systems and the level of integration between manufacturing sites and marketing departments.

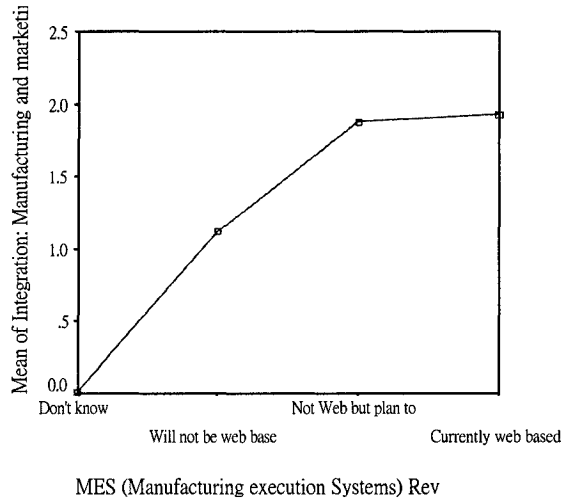


Figure 33: Web-based level of MES systems and level of integration between manufacturing sites and marketing departments

Another example is the relationship between the web-based level of IT systems and the level of integration between R&D and marketing departments. In section 6.2.5, we have learned that the level of integration between R&D and marketing departments is rather low compared to the level of integration between other functional departments. Figure 34 shows a positive insight for this problem. It indicates that the higher the level of web-based IT systems, such as CRM systems, the higher the level of integration between R&D and marketing departments.

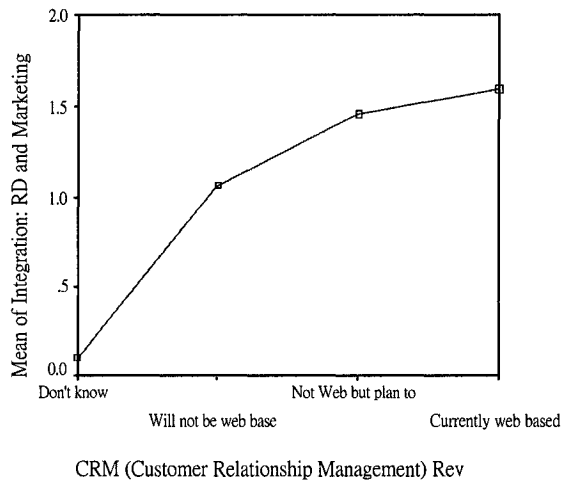


Figure 34: Web-based level of CRM systems and level of integration between R&D and marketing departments

Section conclusion

H₉ (the web-based level of each IT systems is interacted with other IT systems within one company) is **accepted** based on what we have discovered in section 6.7.1. Evidently, all of the

IT systems investigated in this research are highly interacting. Which is to say, the web-based level of IT systems in any subject's company is highly consistent.

H₁₀ (the web-centric level of IT systems tools has higher impact on external communication than internal communication) is **accepted** based on what we have discovered in section 6.7.2. Twice the number of significant relation cells has been found in the external use of communication than in the internal use of communication. Therefore, the hypothesis is confirmed.

H₁₁ (the value of web-based collaborative tools is positively related to the use of web-centric collaborative tools) is **accepted** based on what we have discovered in section 6.7.3. Significant relationships are found in eleven out of fourteen IT systems being investigated. Therefore, we can conclude that the higher the web-based level of IT systems, the higher the value of web-based collaborative tools.

H₁₂ (the level of integration is positively related to the use of web-centric collaborative tools) is **accepted** based on what we have discovered in section 6.7.4. Significant relationships were found in 97.6% of the tests. Therefore, we can conclude that the higher the web-based level of IT systems, the higher the level of integration.

Chapter 7: Data Analysis, Part III - Multivariate Analysis

In section 6.6, the results have shown that the “overall performance” is not influenced alone by any single global variable. Therefore, one of the main objectives of this section is to find out whether or not there are important factors combining more than one variable that have an influence on the “overall performance”. In other words, this section uses multivariate analysis techniques, such as factor analysis, to investigate the interaction between three or more than three variables.

7.1. Use of communication tools

7.1.1. Internal use of communication tools

In this section, we examine the correlations between fourteen variables related to “internal use of communication” (“nq9_1ph” to “nq9_11cu”, see: List of Local variables in Appendix III). The following figures explain the output from factor analysis of these 11 variables. First of all, Figure 35 shows that the distribution of variables is middling adequate for conducting factor analysis, and these data do not produce an identity matrix ¹³.

KMO and Bartlett's Test	
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.764
Bartlett's Test of Sphericity	545.973
Approx. Chi-Square	55
df	.000
Sig.	

Figure 35: Factor analysis of internal use of communication - KMO measure

Second, Figure 36 shows that only two components were extracted and they account for approximately 47.7% of the total variance.

Component	Total Variance Explained					
	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.542	32.202	32.202	3.253	29.569	29.569
2	1.707	15.519	47.721	1.997	18.152	47.721
3	.955	8.680	56.401			
4	.891	8.100	64.501			
5	.767	6.971	71.472			
6	.700	6.361	77.833			
7	.667	6.059	83.893			
8	.572	5.204	89.096			
9	.520	4.725	93.821			
10	.412	3.743	97.564			
11	.268	2.436	100.000			

Extraction Method: Principal Component Analysis.

Figure 36: Factor analysis of internal use of communication - Total variance explained

¹³ A KAISER-MAYER-OLKIN (KMO) measure designates levels as follows: >.09 is marvelous, >.8 is meritorious, >.7 is mediocre, >.5 is miserable, and >.5 is unacceptable. A significance value <.05 indicates that this data does not produce an identity matrix (or “differ significantly from identity”) and is approximately multivariate normal and acceptable for factor analysis (George & Mallery, 2003).

Based on Figure 37, we can learn that the higher loading components (> 0.5) in factor 1 represent the following communication tools: newsgroups, bulletin boards, web conferencing, Extranet, commercialized PDS, customized PDS, and instant messengers. It appears that these seven variables convey a sense of being “leading-edged” technology tools. Moreover, all of these communication tools are network enabled.

Conversely, the higher loading components in factor 2 signify the following communication tools: phones or fax machines, e-mail, and in-house conference meetings. Phones or fax machines and in-house conference meetings are all categorized as the “traditional means of communication” in this study, whereas “e-mail” is one of the earliest network enabled communication tools. Therefore, based on the distinctive components in factor 1 and factor 2, it can be concluded that factor 1 represents the leading-edged communication tools, whereas factor 2 represents older methods of communication.

Rotated Component Matrix

	Component	
	1	2
NO9_5NEW	.787	-.218
NO9_4BU	.745	-.142
NO9_9WEB	.669	.168
NO9_7EXT	.656	.136
NO9_11CU	.600	.209
NO9_10CO	.561	.224
NO9_8IM	.506	.259
NO9_6INT	.481	.458
NO9_1PH		.741
NO9_3EM		.726
NO9_2ME	.175	.660

Extraction Method: Principal Component Analysis
 Rotation Method: Varimax with Kaiser Normalization
 a. Rotation converged in 3 iterations.

Figure 37: Factor analysis of internal use of communication - Component matrix

The next step in carrying out the factor analysis is to plot the elements based on the scores of the elements with regard to the first and the second factors. Figure 38 shows such a result in the form of a scatter plot graph. From Figure 38, we can clearly see that none of the subjects are both high in factor 1 and high in factor 2. In other words, none of these subjects use both high frequency of the leading-edged communication and high frequency of the traditional means of communication at the same time. Most of the subjects use more of the traditional means of communication tools, and less of the leading-edged communication tools, while only a few of the subjects use more of the leading-edged communication tools instead of the traditional means of communication.

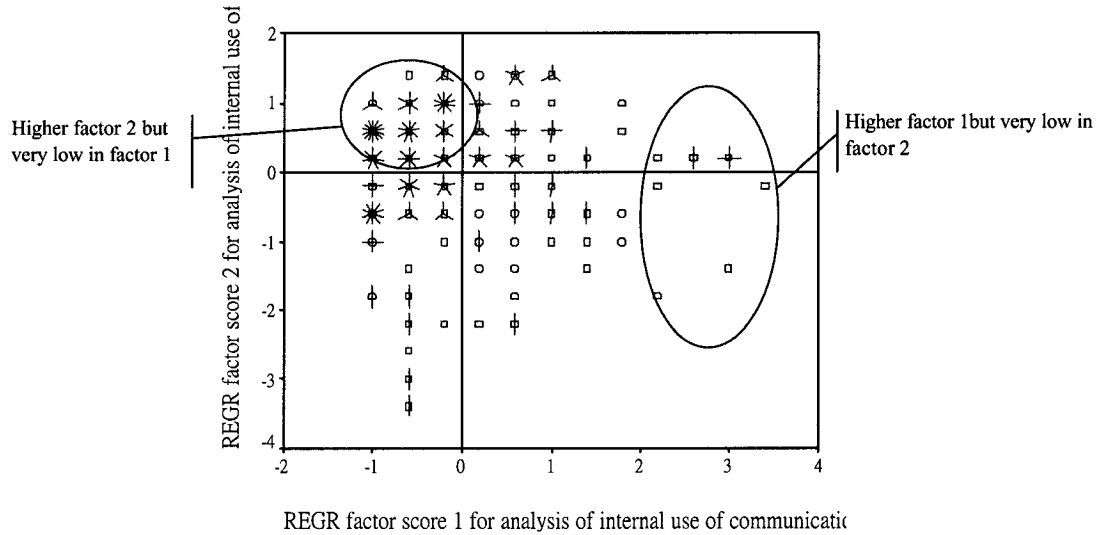


Figure 38: Factor analysis of internal use of communication - Plotting factor scores

The above factor analysis was carried out with only two factors extracted. If we further divide the eleven variables into three factors, it appears that they can be divided, again into three categories:

- Factor 1: bulletin boards, news groups, and web conferencing;
- Factor 2: commercialized PDS, customized PDS, Extranet, and Intranet;
- Factor 3: e-mail, phone/fax, and in-house meetings.

7.1.2. External use of communication tools

When we investigate the external use of communication tools, the results are similar to the outcome we found with the internal use of communication tools, but with even stronger correlations. First, Figure 39 shows that the distribution of values is meritoriously, almost marvelously, adequate for conducting a factor analysis.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.875
Bartlett's Test of Sphericity	1180.121
Approx. Chi-Square	55
df	.000
Sig.	

Figure 39: Factor analysis of external use of communication - KMO measure

Moreover, Figure 40 shows that only two components were extracted. However, in this case, the two factors account for nearly 65% of the total variance, which is higher than previous analysis indicates.

Total Variance Explained

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.361	48.739	48.739	4.437	40.336	40.336
2	1.707	15.522	64.261	2.632	23.925	64.261
3	.700	6.365	70.626			
4	.608	5.530	76.156			
5	.587	5.340	81.496			
6	.526	4.778	86.274			
7	.434	3.949	90.223			
8	.385	3.498	93.721			
9	.290	2.634	96.355			
10	.221	2.013	98.368			
11	.179	1.632	100.000			

Extraction Method: Principal Component Analysis.

Figure 40: Factor analysis of external use of communication - Total variance explained

In addition, we can see from Figure 41 that the higher loading components in factor 1 and factor 2 are very similar to the previous analysis about the internal use of communication tools. However, correction strength for each variable is slightly stronger:

- Factor 1: Bulletin boards, newsgroups, customized PDS, Intranet, web conferencing, commercialized PDS, instant messengers, and Extranet;
- Factor 2: Phone or fax machine, e-mail, and in-house meetings.

Rotated Component Matrix

	Component	
	1	2
NO10_4BU	.856	
NO10_5NE	.842	
NO1011CU	.786	.185
NO10_6IN	.744	.243
NO10_9WE	.701	.292
NO1010CO	.690	.251
NO10_8IM	.659	.273
NO10_7EX	.527	.434
NO10_1PH		.896
NO10_3EM	.138	.887
NO10_2ME	.351	.733

Extraction Method: Principal Component Analysis.
 Rotation Method: Varimax with Kaiser Normalization.
 a. Rotation converged in 3 iterations.

Figure 41: Factor analysis of external use of communication - Component matrix

Figure 42 in the following page shows that, again, none of the subjects use both high frequency of the leading-edge communication tools and the traditional means of communication for the external communication. The biggest difference compared to the internal use of communication is that a comparatively large amount of the subjects use a lower frequency in both factors.

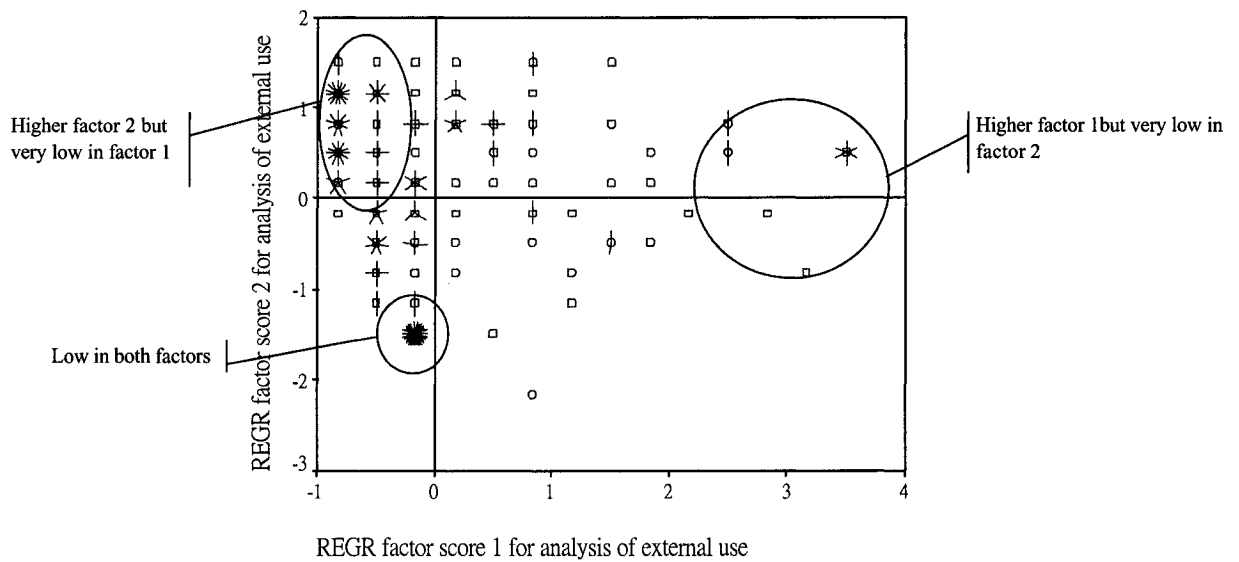


Figure 42: Factor analysis of external use of communication - Plotting factor scores

7.2. Overall project performance

In order to figure out which combination of variables might have the contribution to the variance of the overall project performance, we first conducted a factor analysis with all the local variables. Figure 43 shows that the data value is adequate for factor analysis. However, Figure 44 shows that it requires up to twenty-six factors to explain approximately 71% of the total variance. The cumulative effect of the total variance increases incrementally because of the increased number of factors. Thus, the results have shown that the total variance cannot simply be explained by a reasonable number of variables.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.739
Bartlett's Test of Sphericity	Approx. Chi-Square
	9390.642
	df
	3916
	Sig.
	.000

Figure 43: Factor analysis of all variables- KMO measure

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	14.114	15.858	15.858	8.113	9.116	9.116
2	5.694	6.398	22.257	7.491	8.417	17.532
3	4.706	5.287	27.544	3.406	3.827	21.359
4	3.003	3.374	30.919	3.340	3.752	25.112
5	2.777	3.120	34.039	3.333	3.745	28.857
6	2.631	2.956	36.994	2.896	3.254	32.111
7	2.350	2.640	39.634	2.733	3.071	35.182
8	2.137	2.402	42.036	2.046	2.298	37.480
9	2.049	2.302	44.338	1.891	2.125	39.605
10	1.968	2.211	46.549	1.860	2.090	41.694
11	1.878	2.111	48.660	1.846	2.074	43.769
12	1.741	1.957	50.617	1.816	2.040	45.809
13	1.657	1.862	52.479	1.763	1.981	47.790
14	1.611	1.810	54.289	1.756	1.973	49.763
15	1.543	1.734	56.023	1.744	1.960	51.722
16	1.475	1.657	57.680	1.704	1.915	53.637
17	1.364	1.532	59.212	1.698	1.908	55.545
18	1.337	1.502	60.714	1.688	1.896	57.442
19	1.284	1.443	62.158	1.663	1.869	59.310
20	1.255	1.410	63.568	1.555	1.747	61.058
21	1.196	1.343	64.911	1.553	1.745	62.803
22	1.162	1.306	66.217	1.522	1.710	64.513
23	1.130	1.269	67.486	1.521	1.709	66.221
24	1.106	1.242	68.729	1.513	1.700	67.921
25	1.056	1.186	69.915	1.456	1.636	69.557
26	1.014	1.139	71.054	1.331	1.496	71.054
27	.963	1.082	72.136			

Figure 44: Factor analysis of all variables - Total variance explained

Yet, if we select only the subjects with “extremely successful” project performance, and eliminate some less important variables (proved by previous chapter), we can obtain more meaningful results. Figure 45 shows the total variance can be explained up to 87.7% by twelve factors¹⁴.

Total Variance Explained ^a						
Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	11.619	27.665	27.665	8.633	20.555	20.555
2	6.304	15.009	42.675	5.292	12.600	33.155
3	3.025	7.203	49.877	5.010	11.929	45.084
4	2.894	6.890	56.767	2.946	7.015	52.099
5	2.445	5.822	62.590	2.348	5.590	57.689
6	1.959	4.665	67.255	2.222	5.290	62.979
7	1.931	4.599	71.853	2.174	5.176	68.156
8	1.598	3.806	75.659	1.846	4.395	72.550
9	1.429	3.403	79.062	1.668	3.973	76.523
10	1.307	3.112	82.174	1.592	3.790	80.313
11	1.192	2.837	85.012	1.588	3.781	84.094
12	1.141	2.717	87.728	1.526	3.634	87.728
13	.757	1.803	89.532			
40	3.843E-16	-9.151E-16	100.000			
41	5.725E-16	-1.244E-15	100.000			
42	7.037E-16	-1.676E-15	100.000			

Extraction Method: Principal Component Analysis.

a. Only cases for which Overall performance (Rev) = Extremely successful are used in the anal

Figure 45: Factor analysis of successful project performance subjects - Total variance explained

¹⁴ Only local variables with relation to the size of the company, the product type, the complexity of the project, the web-based level of IT systems, the internal use of communication, and the external use of communication are included in this factor analysis.

However, Figure 46 shows that only four factors would be sufficient to explain the total variance. The results of extracting only four factors (see Figure 47) have shown that approximately 57% of the total variance is explained by these four factors.

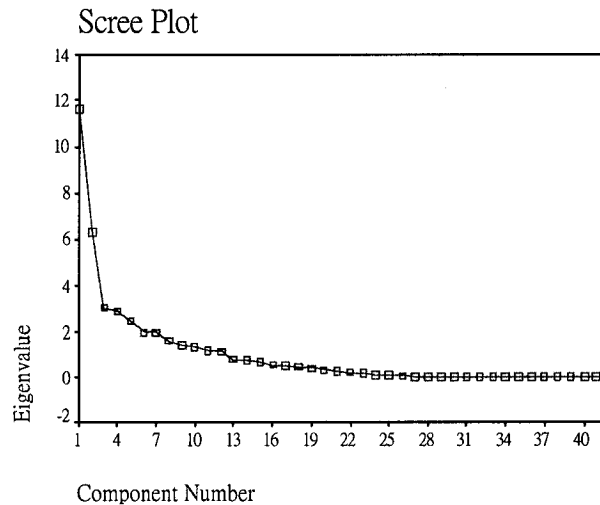


Figure 46: Factor analysis of successful project performance subjects – Scree plot

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	11.619	27.665	27.665	8.699	20.717	20.717
2	6.304	15.009	42.675	5.685	13.536	34.248
3	3.025	7.203	49.877	5.400	12.857	47.105
4	2.894	6.890	56.767	4.058	9.662	56.767
5	2.445	5.822	62.590			
6	2.021	4.959	67.549			
39	3.545E-16	-8.441E-16	100.000			
40	3.843E-16	-9.151E-16	100.000			
41	5.225E-16	-1.244E-15	100.000			
42	7.037E-16	-1.676E-15	100.000			

Extraction Method: Principal Component Analysis.

a. Only cases for which Overall performance (Rev) = Extremely successful are used in the anal

Figure 47: Factor analysis of successful project performance subjects – Total variance explained (4 factors)

The four factors are:

- Factor 1: the fourteen web-based IT systems are all included in this factor;
- Factor 2: the external/internal use of news groups, bulletin boards, customized PDS and the internal use of Extranet;
- Factor 3: the external use of instant messenger, Intranet, web conferencing, in-house meetings and the internal use of web-conferencing, and instant messenger;
- Factor 4: the external use of a phone or a fax machine and e-mail.

Therefore, we can conclude that the combination of the level of web-base IT systems, the internal and external use of communication are the primary factor that affect to the overall project performance. However, this combination can only explain approximately 57% of the total variance. Which is to say, the factors that explain the remaining 43% of the variance have not yet been identified (For detailed factor information, please refer to Appendix IV: The output of factor).

7.3. Organizational (schedule) project performance

Similarly, we applied the same group of variables to analyze the factors that affect the organizational (schedule) project performance. Figure 48 shows that nine factors were extracted, and that they can explain approximately 81% of the total variance. Only the subjects with the highest organizational (schedule) project performance were analyzed in this testing.

Total Variance Explained^a

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	14.247	33.922	33.922	8.761	20.859	20.859
2	5.163	12.292	46.214	7.228	17.210	38.069
3	3.805	9.059	55.273	4.008	9.543	47.612
4	2.155	5.131	60.404	3.535	8.418	56.029
5	2.063	4.912	65.316	2.378	5.663	61.692
6	2.004	4.773	70.088	2.263	5.389	67.082
7	1.678	3.995	74.084	2.085	4.963	72.045
8	1.507	3.589	77.672	1.849	4.402	76.447
9	1.275	3.035	80.707	1.789	4.260	80.707
10	.988	2.352	83.059			
11	.931	2.217	85.276			
40	3.356E-16	-7.991E-16	100.000			
41	3.563E-16	-8.483E-16	100.000			
42	8.672E-16	-2.065E-15	100.000			

Extraction Method: Principal Component Analysis.

a. Only cases for which On Schedule (REV) = 5 are used in the analysis phase.

Figure 48: Factor analysis of successful project performance subjects – within schedule

Again, based on the Scree plot (see Figure 49), we can learn that five factors can be sufficient to explain the total variance. Figure 50 shows that five factors can explain approximately 65% of the total variance.

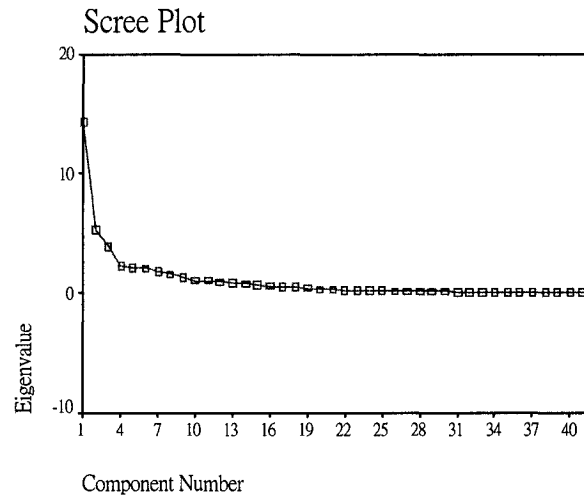


Figure 49: Factor analysis of successful project performance subjects – within schedule

Total Variance Explained^a

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	14.247	33.922	33.922	8.947	21.303	21.303
2	5.163	12.292	46.214	8.063	19.197	40.501
3	3.805	9.059	55.273	4.426	10.537	51.038
4	2.155	5.131	60.404	3.178	7.566	58.604
5	2.063	4.912	65.316	2.819	6.712	65.316
6	2.004	4.773	70.088			
40	-3.356E-16	-7.991E-16	100.000			
41	-3.563E-16	-8.483E-16	100.000			
42	-8.672E-16	-2.065E-15	100.000			

Extraction Method: Principal Component Analysis.

a. Only cases for which On Schedule (REV) = 5 are used in the analysis phase.

Figure 50: Factor analysis of successful project performance subjects – within schedule (5 factors)

According to the rotated component matrix in Appendix V: The output of factor analysis for organizational (schedule) project performance, the five factors extracted are:

- Factor 1: the fourteen web-based IT systems and the complexity of the project;
- Factor 2: the external/internal use of news groups, bulletin boards, customized PDS, web conferencing, commercialized PDS, the external use of instant messenger and Intranet;
- Factor 3: the external use of phone or fax, e-mail, in-house meetings and the internal use of Extranet;
- Factor 4: systems software, military software and “others” software;
- Factor 5: the external use of Extranet and the internal use of in-house meetings and a phone or a fax machine.

The results here have shown that there are some significant differences between the factors that affect the overall project performance and the factors that affect the organizational (schedule) project performance. First, the project complexity is negatively correlated to the total variance (correlation = - 0.540). It appears that the organizational (schedule) project performance is negatively related to the complexity of the project. Second, the types of products are included in factor 4. Which is to say, the product type also has influence on the organizational (schedule) project performance.

To conclude, the combination of the level of web-based IT systems, the project complexity, the internal and external use of communication tools, and the types of products can explain a sum up to 65% of the total variance of the success of organizational (schedule) project performance.

Chapter 8: Conclusion and Future work

8.1. Restriction and scope of this research

Restriction and scope of this research can be discussed from two aspects: the first one is the limitation of the time and the resources, and the second restriction is the limitation from *InsightExpress*, since the survey was launched following their policies.

In the initial stage of designing the questionnaire, the limitation to the maximum allowed number of questions in each survey and the elements for each question from *InsightExpress* (see 4.1 Data inquiry method) have always been considered as the most difficult restriction to perform the cross-examination of variables. However, as the data analysis moved along, it turned out that the questionnaire had contained too many variables to conduct bivariate data analyses, not to mention multi-variable analyses. Moreover, the enormous variable matrices had made the data analyses more complex. Since there were too many variables and the research time was limited, only a few statistical tests had been performed compared to the original plan.

Aside from the above-mentioned restrictions, there are still some limitations to this online survey conducted through *InsightExpress*. Since the contact information of the respondents was solely within *InsightExpress*, follow-up interviews or further in-depth surveys could not be done as planned.

Nevertheless, the process of this web-based survey is, overall, much more effective than the conventional market research methods.

8.2. Summary of the research results

In summary, six out of twelve hypotheses were accepted. The accepted hypotheses include the following:

1. H₄: The subjects who develop different types of software products use different web-based IT systems;
2. H₅: The subjects who develop different types of software products use collaborative tools for different purposes;
3. H₉: The web-based level of each IT systems is interacted with other IT systems within one company;

4. H₁₀: The web-centric level of IT systems tools has higher impact on external communication than internal communication;
5. H₁₁: The value of web-based collaborative tools is positively related to the use of web-centric collaborative tools;
6. H₁₂: The level of integration is positively related to the use of web-centric collaborative tools.

The confirmations of H₄, H₅, and H₉ have made the marketing strategy extremely important to the diffusion of web-based collaborative tools. Moreover, the acceptance of H₁₁ and H₁₂ also proves that web-based collaborative tools are value-added investments to management.

In addition, two hypotheses were only partially accepted due to the insufficient evidence from this questionnaire. They are:

1. H₁: Team members who work in different roles on the projects use collaborative tools for different purposes.
2. H₆: The more complex the software products, the higher the use of web-centric collaborative tools.

The above findings have provided a glimpse of the current activities. However, four hypotheses were surprisingly overruled.

1. H₂: The web-based level of collaborative tools is positively related to the size of the company.
2. H₃: The larger the size of the company, the harder the transformation of web-based collaborative tools.
3. H₇: The project performance elements are positively related to the use of web-centric collaborative tools.
4. H₈: The overall project performance is positively related to the use of web-centric collaborative tools.

The rejections of H₇ and H₈ are rather discouraging for this study. We had expected to obtain positive insights for these two most important hypotheses. For example, the use of CPD tools does not seem to affect the overall project performance alone by itself. It may have potential influences in conjunction with other factors. In chapter 7, the results have shown that the overall project performance may have been influenced by the combination of: the level of web-based IT systems, the internal and the external use of communication tools. However, this combination can

only explain approximately 57% of the total variance. There are still some factors that this study failed to identify.

The following table contains a list of the results for each hypothesis:

	Hypothesis	Dependant Variable	Independent Variable	Result
1	H ₁	Purposes	Role	Partially accepted
2	H ₂	IT systems	Size of the company	Rejected
3	H ₃	Obstacles	Size of the company	Rejected
4	H ₄	IT systems	Type of product	Accepted
5	H ₅	Purposes	Type of product	Accepted
6	H ₆	IT systems	Complexity of the product	Partially accepted
7	H ₇	Performance elements	IT Systems	Rejected
8	H ₈	Overall performance	IT Systems	Rejected
9	H ₉	IT Systems	IT Systems	Accepted
10	H ₁₀	Internal/External communication	IT Systems	Accepted
11	H ₁₁	Value of the tool	IT Systems	Accepted
12	H ₁₂	Functional integration	IT Systems	Accepted

Figure 51 presents the findings from another angle. It is also the outcome from Figure 4: Variable relationships. One of the four input variables examined in this study have been declared as no real impact to the use of web-based collaborative tools: the size of the enterprise. The product type, on the other hand, does have an impact on the use of web-based collaborative tools. The role of the participant and the product complexity only have partial influence on the use of web-based collaborative tools, such as internal communication and some of the IT systems. But these two variables are not the major causes to the use of web-based collaborative tools.

In addition, the use of web-based collaborative tools does have a positive input to the value of web-based collaborative tools, and the level of functional integration. The users who have intensive experience on this tool tend to agree that this tool is valuable. The companies which use web-based collaborative tools also have higher levels of functional integration.

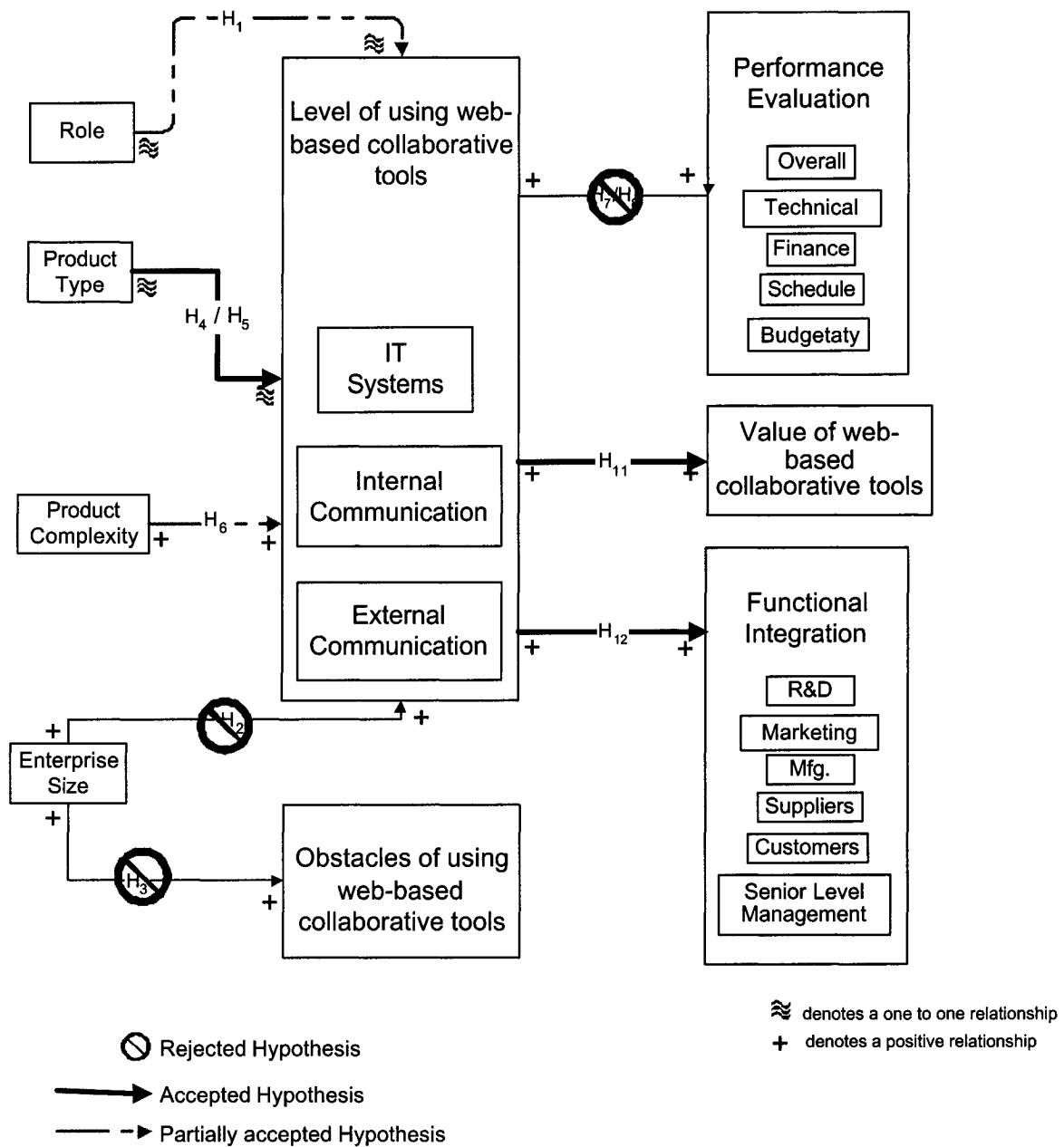


Figure 51: Findings of variable relationships

Finally, this research would like to emphasize to managers and project leaders to hesitate in integrating web-centric collaborative techniques and tools without careful consideration. Web-centric collaborative techniques and tools are not the answer to all problems. The process of moving from legacy systems to web-centric systems is expensive and therefore, a clear strategy should be taken into consideration. One needs to ask various questions such as: is there a need for web-centric collaborative systems? Have the obstacles and the resistance of adapting such systems in the company been identified? More importantly, are there people to do the work of transformation? (Thuraisingham, 1999)

8.3. Future challenges

There are two categories of future challenges. First, the methodology applied in this research can be further extended. Second, the target respondents can also be further extended to other industries.

In the formal case of methodology, more statistical tests, such as multiple regressions and MANOVA are considered to be a challenging work possible in the future. Moreover, quantitative data analysis using SPSS with the amount of variables (93 variables) in this research was very time-consuming. This research suggests that it is necessary to use more advanced data mining tools to perform top-down data analysis instead of bottom-up data analysis.

For the latter case, the comparison between the software industry (comparatively more high-tech industry) and the other less high-tech industries can also be a possible future challenging work.

Finally, web-centric collaborative systems are not “stand-alone technologies”. There still is a great deal to accomplish, many challenges to overcome and new problems to solve. In many cases it might be effective to start with a small pilot project or a prototype before going into full-scaled collaboration. A final point is that web-centric collaborative systems would bring enormous advantages only if with complete preparation of thesis systems and with a clear vision in this field.

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APPENDICES

Appendix I. Questionnaire for the research

Web-centric Collaborative Product Development Survey

Thank you for taking part in this survey. The purpose of this survey is to investigate the influence of web-centric collaborative tools on the New Product Development (NPD) process in software development industry. Your valuable information will help us better understand the current market status.

Before answering this questionnaire, please picture in your mind a specific new product development process you have participated during the last six months. Circle the most suitable answer based on "how things actually were during the development of this project" rather than on "how things ought to be".

Definitions:

- | |
|---|
| <ul style="list-style-type: none">- New product development (NPD): The term <i>new products</i> refers to products (e.g., software, tangible objects) commercialized by your firm and new to your firm, even though similar products may have already been on the market. |
|---|

2. What was your role for this specific new product development project?
 - Team Leader / Project manager / General Manager
 - Software Developer
 - Testing Engineer
 - Manufacturing Engineer
 - Quality Assurance Engineer
 - Supplier
 - Procurement
 - Marketing / Sales
 - Customer
 - Others (Please specify)
 - There was not a new product development project in the last six months

3. How many employees currently work in your company?
 - Fewer than 50
 - 50 to 249
 - 250 to 499
 - 500 to 999
 - 1,000 to 2,500
 - More than 2,500

4. What type of new products are you delivering to the software industry? (Select at least one)

- Business software / In-house systems (systems that are used by a single organization, such as payroll systems, accounting systems, and inventory control systems)
- Firmware
- Military software
- Shrink-wrap software (packaged and sold commercially, including both horizontal-market products like work-processors and spread-sheets and vertical-market products like financial-analysis, and legal case-management programs)
- Systems software (includes operating system software, device drivers, compilers and code libraries)
- Others (Please specify)

5. Using the following scale, please indicate the level of technical complexity that was necessary to implement this new product. (Based on its major functional components)

Extremely Simple (only 1) 1 2 3 4 5 6 7 Extremely Complex (more than 7 components)

6. Using a scale from 1 to 7 where 7 means "Strongly Agree" and 1 means "Strongly Disagree," how much do you agree or disagree with the following statements?

		Strongly Agree						Strongly Disagree	Don't know
a) The project was a technical success relative to other projects of the company	7	6	5	4	3	2	1	0	
b) The project was a financial success relative to other projects of the company	7	6	5	4	3	2	1	0	
c) The project was completed within the budget relative to the initial objective	7	6	5	4	3	2	1	0	
d) The project was completed on schedule relative to the initial objective	7	6	5	4	3	2	1	0	

7. Overall, how successful was the new product development project?

- Extremely successful
- Very successful
- Somewhat successful
- Not too successful
- Not at all successful
- Don't know

8. For each of the following IT systems, please indicate whether the system is currently web based, planned to be web based or will not be web based? (Check ALL that apply)

- | | |
|---|---|
| Activity-based costing (ABC) | Advanced planning and scheduling (APS) |
| Component and supplier management (CSM) | Computer-integrated manufacturing (CIM) |
| Customer relationship management (CRM) | Data warehousing |
| Design systems (CAD, CAM, etc.) | Electronic data interchange (EDI) |
| Enterprise resource planning (ERP) | Manufacturing execution systems (MES) |
| Order management configuration | Problem tracking systems (PTS) |
| Product data management (PDM) | Warehouse management systems (WMS) |
| Others (Please specify) | None of these |

9. How often did you exchange project information **internally** (with other project team members) using the following technologies?

		Low	Moderate	High	Never
a)	Phone/Fax				
b)	In-house conference meeting				
c)	Electronic mail				
d)	Bulletin Board				
e)	Newsgroup				
f)	Intranet				
g)	Extranet				
h)	Instant messaging				
i)	Web conferencing				
j)	Commercialized product development software				
k)	Customized product development software				

10. How often did you exchange project information **externally** (with customers / suppliers) using the following technologies?

		Low	Moderate	High	Never
a)	Phone/Fax				
b)	In-house conference meeting				
c)	Electronic mail				
d)	Bulletin Board				
e)	Newsgroup				
f)	Intranet				
g)	Extranet				
h)	Instant messaging				
i)	Web conferencing				

j)	Commercialized product development software				
k)	Customized product development software				

11. Based on the definition of "collaborative tools", was there any **web-based** collaborative tool available for this project? If so, the web-based collaborative tool you will describe overall as:

Note:

❖ Collaborative tools (groupware) are computer-based tools that help people work together and share information. They allow for virtual on-line meetings and data sharing.

- Extremely Valuable
- Valuable
- Neither valuable nor not valuable
- Not valuable
- Not at all valuable
- No web based collaborative tool available for the project

12. Based on your experience, please identify the following benefits of collaborative product development tools

Note:

- Collaborative tools (groupware) are computer-based tools that help people work together and share information. They allow for virtual on-line meetings and data sharing.
- Collaborative Product Development is performed either at multiple sites within an enterprise, or beyond the enterprise using collaborative tools, where it involves more than one organization.

Enable automated source-code control

Enable 24/7 design

Enable real-time communication

Increase product innovation

Increase process innovation

Increased competition

Increased prices

Reduce cost and waste

Reduced competition

Reduced prices

Shortened product lifecycle

Others (Please specify)

None of these

13. Describe the purpose of the collaborative tool you used for this project. (Check all that apply)

- Exchange of project management information (timetables, project plans, costing...etc)
- Exchange of product related information (driver, user manual...etc)

- Exchange of development documentation
- Real-time communication with other team members
- Response to sales order
- Place purchase order
- Management production information
- Inventory control
- Provide customer service
- Others (Please specify)

14. Which of the following obstacles and resistances best describes your web-based collaborative product development systems? (Select all that apply)

- Non-compatible systems (wide adoption of incompatible systems)
- Difficulty to integrate multiple systems (and create significant competitive barriers for small and medium enterprises)
- Inability for suppliers and customers to agree upon and implement the process standards
- Security and desire to keep sensitive data within the boundaries of internal firewalls
- CPD increased IT expenses with lower return (reduction of product life cycle, cost savings, potential product innovation)
- Lack of consensus between partners
- Crowded and complex CPD with hundreds of providers
- Lack of web expertise
- OEM strategy for integrating product development processes with industry exchanges is still unclear
- Failure to identify the proper balance between cost saving and the competition
- Industry resistance to change
- Difficulty to adapt existing legacy systems
- Others (Please specify)

15. Using the following scale, please rate the degree of integration with each of the following departments during the entire development process:

		Low		Moderate		High	Don't know
a)	Between RD and manufacturing						
b)	Between RD and marketing						
c)	Between manufacturing and marketing						
d)	With suppliers / contractors						
e)	With customers						
f)	Involvement of senior level management						

Appendix II. InsightExpress recruitment methodology

InsightExpress Recruitment Methodology

Critical to the quality of any research initiative is the quality of the underlying sample.

InsightExpress uses a proven, advanced e-RDD recruitment technique to reach more than 90,000,000 online individuals from tens of thousands of Web sites—proactively soliciting participation in surveys using a wide array of invitation methods (i.e., hyperlinks, pop-ups, banners, e-mails, etc.). This approach produces a remarkably reliable, stable, scalable, and projectable sample.

From a process perspective, individuals accepting an *InsightExpress* survey invitation are presented with a short screening questionnaire. Based upon provided answers and additional criteria, a respondent is randomly assigned to an appropriate *InsightExpress* survey (if any).

When evaluating recruitment methodologies, several parameters must be considered to understand the continuum of applicability and quality.

Reliability

Research results can be considered reliable if two surveys fielded concurrently to the same audience yield the same results. Through our patent-pending technology and randomization procedures, *InsightExpress* surveys meet this criterion. In fact, all Research-On-Research initiatives have yielded no statistical differences at the 90% confidence level.

Stability

Research can be considered stable if identical surveys fielded at different times produce repeatable results (assuming no external variables have changed). As *InsightExpress* recruits from tens of thousands of Web sites, uses a wide variety of invitation mechanisms, and reaches more than 90,000,000 potential respondents, our samples are stable as a result of diversification and randomization at multiple dimensions.

Bias

All research methodologies possess some inherent biases. The goal, however, is to understand the source of the bias and account for it when making business decisions. *InsightExpress* manages and minimizes bias on several key dimensions, including:

- ❑ **Self selection bias:** Respondents are *invited* to participate in surveys. That is, they cannot visit a specific URL or decide to offer their opinion on a specific topic. This approach eliminates the phenomenon of “professional, paid respondents.”
- ❑ **Sample selection bias:** Respondents are *randomly recruited* from the largest aggregation of Web sites and invitation methods on the Internet. This approach eliminates sample bias through diversification and randomization — a fundamental underpinning of sampling theory and sound market research principles.
- ❑ **Non-response bias:** *InsightExpress* surveys typically contain up to 20 questions as shorter surveys have higher completion rates. In the online environment, being mindful of respondent workload is the single largest factor impacting research quality.

Representivity

By the nature of the techniques employed to recruit respondents, *InsightExpress* results are 100% representative and completely projectable to the U.S. online population. However, representivity does not stop there. As *InsightExpress*' advanced recruiting techniques provide access to nearly 60% of the general U.S. population (see below), many needs among many market segments can be met using *InsightExpress*' recruitment methodology.

Criteria	2001 Online Population*	U.S. Population (2000 Census)
Male	49%	49%
Female	51%	51%
Marital Status: Married	53%	53%
Household Income	\$49,000	\$40,816**
Adults 18-49	76%	63%
Adults 50+	24%	37%

* *InsightExpress* sample

**1999 U.S. Census

Furthermore, Research-On-Research comparing online and offline surveys has demonstrated *InsightExpress*' recruitment methodology produces results nearly identical to those obtained using traditional mail panels—enabling mail research to be confidently replaced with *InsightExpress*' approach.

Summary

InsightExpress provides a high-quality, stable, and reliable source of respondents that can be applied for online as well as traditional research applications. And using this approach, *InsightExpress* delivers virtually an unlimited number of “fresh” respondents—overcoming the shortcomings of other sampling methodologies.

Appendix III. List of all variables

Two groups of variables are used in this research: global and local. For each question in the questionnaire, there is one global variable. Each global variable may, again, consists of one or more than one local variables. Local variables are the variables for actual statistical tests, whereas global variables are for conceptual interpretation.

1. List of Global variables

	Name	Note
Q1	None	There are no variable in question 1.It is a statement for this survey.
Q2	Role	Indicate the respondent's role in the project
Q3	Size	Indicate the size of respondent's company
Q4	PType	Type of software product
Q5	Complexity	Complexity of software product
Q6	Performance elements	<input type="checkbox"/> 1) Technical <input type="checkbox"/> 2) Financial <input type="checkbox"/> 3) Budget <input type="checkbox"/> 4) Schedule
Q7	Overall Performance	Overall Performance of the project
Q8	IT systems	Web-based tools
Q9	Internal communication	Communication methods (internal)
Q10	External Communication	Communication methods (External)
Q11	Value of the tool	Value of web-centric CPD software
Q12	Benefit	Benefit of web-centric CPD software
Q13	Purpose	Purpose of using web-centric CPD software
Q14	Obstacles	Obstacles of using web-centric CPD software
Q15	Functional integration	The integration level between NPD functions

2. List of Local variables

	Label	Name	Type
1	Role of the project	q2_role	Nominal
2	Size of the organization	q3_size	Ordinal
3	Type of Product: Business	q4_1_bus	Nominal
4	Type of Product: Firmware	q4_2_fir	Nominal
5	Type of Product: Military	q4_3_mil	Nominal
6	Type of Product: Shrink-wrap	q4_4_shr	Nominal
7	Type of Product: Systems	q4_5_sys	Nominal
8	Type of Product: Others	q4_6_oth	Nominal
9	Complexity of the product	q5_cplx	Ordinal
10	Technical Success (Rev)	nq6_1tec	Ordinal
11	Financial Success (Rev)	nq6_2fin	Ordinal
12	Within Budget (Rev)	nq6_3bgt	Ordinal
13	On Schedule (Rev)	nq6_4sch	Ordinal
14	Overall performance (Rev)	nq7ovral	Ordinal
15	ABC (Activity Based costing) (Rev)	nq8_1abc	Nominal

16	APS (Advanced Planning and scheduling) Rev	nq8_2aps	Nominal
17	CSM (Component and supplier management) Rev	nq8_3csm	Nominal
18	CIM (Computer-integrated manufacturing) Rev	nq8_4cim	Nominal
19	CRM (Customer Relationship Management) Rev	nq8_5crm	Nominal
20	Data warehousing Rev	nq8_6_dw	Nominal
21	Design Systems (CAD, CAM) Rev	nq8_7_ds	Nominal
22	EDI (Electronic data interchange) Rev	nq8_8edi	Nominal
23	ERP (enterprise resource planning) Rev	nq8_9erp	Nominal
24	MES (Manufacturing execution Systems) Rev	nq8_10me	Nominal
25	Order management configuration Rev	nq8_11om	Nominal
26	PTS (Problem tracking systems) Rev	nq8_12pt	Nominal
27	PDM (Product data management) Rev	nq8_13pd	Nominal
28	Warehouse management systems (WMS) Rev	nq8_14wm	Nominal
29	Internal Phone / Fax	nq9_1_ph	Ordinal
30	Internal In house conference meeting	nq9_2_me	Ordinal
31	Internal Email	nq9_3_em	Ordinal
32	Internal Bulletin Board	nq9_4_bu	Ordinal
33	Internal Newsgroup	nq9_5new	Ordinal
34	Internal Intranet	nq9_6int	Ordinal
35	Internal Extranet	nq9_7ext	Ordinal
36	Internal Instant Messaging	nq9_8im	Ordinal
37	Internal Web conferencing	nq9_9web	Ordinal
38	Internal Commercialized PDS	nq9_10co	Ordinal
39	Internal Customized PDS	nq9_11cu	Ordinal
40	External Phone / Fax	nq10_1ph	Ordinal
41	External In house conference meeting	nq10_2me	Ordinal
42	External Email	nq10_3em	Ordinal
43	External Bulletin Board	nq10_4bu	Ordinal
44	External Newsgroup	nq10_5ne	Ordinal
45	External Intranet	nq10_6in	Ordinal
46	External Extranet	nq10_7ex	Ordinal
47	External Instant Messaging	nq10_8im	Ordinal
48	External Web conferencing	nq10_9we	Ordinal
49	External Commercialized PDS	nq1010co	Ordinal
50	External Customized PDS	nq1011cu	Ordinal
51	Value of this tool	q11value	Ordinal
52	12 Purpose: Enable Auto source-code	q12_1	Nominal
53	12 Purpose: Enable 24/7 design	q12_2	Nominal
54	12 Purpose: Enable real-time communication	q12_3	Nominal
55	12 Purpose: Increase Product innovation	q12_4	Nominal
56	12 Purpose: Increase Process innovation	q12_5	Nominal
57	12 Purpose: Increased Competition	q12_6	Nominal
58	12 Purpose: Increased Prices	q12_7	Nominal
59	12 Purpose: Reduce cost and waste	q12_8	Nominal
60	12 Purpose: Reduced Competition	q12_9	Nominal
61	12 Purpose: Reduced Prices	q12_10	Nominal
62	12 Purpose: Shortened Product lifecycle	q12_11	Nominal
63	12 Purpose: Others	q12_12	Nominal
64	12 Purpose: None of these	q12_13	Nominal

65	13 Purpose: 13: Exchange Project management info.	q13_1	Nominal
66	13 Purpose: Exchange Product related info.	q13_2	Nominal
67	13 Purpose: Exchange development documentation.	q13_3	Nominal
68	13 Purpose: Real-time communication	q13_4	Nominal
69	13 Purpose: Response to sales order	q13_5	Nominal
70	13 Purpose: Place purchase order	q13_6	Nominal
71	13 Purpose: Management Production info.	q13_7	Nominal
72	13 Purpose: Inventory Control	q13_8	Nominal
73	13 Purpose: Provide Customer Service	q13_9	Nominal
74	13 Purpose: Others	q13_10	Nominal
75	14 Obstacle: Difficulty to adapt existing legacy systems	q14_1	Nominal
76	14 Obstacle: increased IT expenses	q14_2	Nominal
77	14 Obstacle: Crowded CPD providers	q14_3	Nominal
78	14 Obstacle: Failure to identify balance cost/competition	q14_4	Nominal
79	14 Obstacle: Industry resistance	q14_5	Nominal
80	14 Obstacle: Inability for suppliers/customers to agree	q14_6	Nominal
81	14 Obstacle: Lack of consensus between partners	q14_7	Nominal
82	14 Obstacle: Lack of web expertise	q14_8	Nominal
83	14 Obstacle: Non-compatible systems	q14_9	Nominal
84	14 Obstacle: OEM strategy	q14_10	Nominal
85	14 Obstacle: Security	q14_11	Nominal
86	14 Obstacle: Others	q14_12	Nominal
87	Integration: between RD and manufacturing	q15_1	Ordinal
88	Integration: between	q15_2	Ordinal
89	Integration: between manufacturing and marketing	q15_3	Ordinal
90	Integration: with suppliers	q15_4	Ordinal
91	Integration: with customers	q15_5	Ordinal
92	Involvement of senior level management	q15_6	Ordinal

Appendix IV. Correction matrix (ordinal by ordinal variables)

Correlations

Spearman's rho	Size of the organization	Complexity of product	Technical Success (rev)	Financial Success (rev)	Within Budget (REV)	On Schedule (REV)	Overall Performance	Internal Phone / Fax	Internal In house confer meeting	Internal Email
	1.000	.088	.070	-.098	.067	-.064	.000	-.065	.186**	.089
	.088	1.000	.325	.166	.347	.365	.997	.363	.008	.210
	.215	.1000	.014	-.102	-.183**	-.117	-.032	.149*	.098	.216**
	.070	.014	1.000	.425**	.376**	.378**	-.593**	.110	.054	.118
	.325	.846	.000	.000	.000	.000	.000	.121	.451	.097
	.098	-.102	.425**	1.000	.438**	.375**	-.494**	-.014	-.019	.075
	.166	.150	.000	.000	.000	.000	.000	.839	.790	.291
	.067	-.183**	.376**	.438**	1.000	.627**	-.439**	.041	.050	.052
	.347	.010	.000	.000	.000	.000	.000	.568	.483	.466
	.064	-.117	.378**	.375**	.627**	1.000	-.472**	.035	.028	.015
	.365	.098	.000	.000	.000	.000	.000	.620	.690	.828
	.000	-.032	-.593**	-.494**	-.439**	-.472**	1.000	-.069	-.073	-.125
	.997	.650	.000	.000	.000	.000	.000	.334	.306	.078
	.065	.149*	.110	.014	.041	.035	-.069	1.000	.336**	.371**
	.363	.035	.121	.839	.568	.620	.334	.000	.000	.000
	.186**	.098	.054	-.019	.050	.028	-.073	.336**	1.000	.319**
	.008	.166	.451	.790	.483	.690	.306	.000	.000	.000
	.089	.216**	.118	.075	.052	.015	-.125	.371**	.319**	1.000
	.210	.002	.097	.291	.466	.828	.078	.000	.000	.000
	-.135	.045	.017	-.076	-.060	-.052	.032	-.065	.126	.000
	.057	.524	.808	.287	.398	.465	.653	.359	.075	.997
	-.101	.070	.027	.010	-.055	-.029	-.035	-.140*	.014	-.026
	.157	.327	.705	.893	.439	.688	.618	.048	.839	.712
	.002	.174*	.123	.003	.043	.079	-.129	.128	.336**	.294**
	.983	.014	.082	.967	.548	.267	.069	.070	.000	.000
	-.116	.114	.014	.024	-.119	-.079	.051	.100	.082	.020
	.102	.108	.846	.737	.092	.264	.473	.160	.247	.781
	-.017	.085	-.059	.058	.032	.026	.076	.141*	.136	.175*
	.816	.232	.404	.418	.649	.718	.283	.046	.055	.013
	.038	.034	.032	.084	.022	.123	-.081	.082	.201**	.107
	.589	.637	.463	.237	.762	.082	.256	.251	.004	.131
	-.026	.124	-.066	.104	.072	.011	.019	.111	.159*	.104
	.710	.080	.353	.144	.309	.875	.792	.118	.024	.144
	-.059	.165*	.024	.052	.065	.021	-.019	.056	.088	.128
	.407	.019	.733	.467	.363	.773	.786	.434	.217	.071
	-.052	.061	.086	.041	.024	.070	-.010	.238**	.184**	.211**
	.468	.390	.227	.566	.740	.325	.885	.001	.009	.003

Correlations

	Size of the organization	Complexity of product	Technical Success (rev)	Financial Success (rev)	Within Budget (REV)	On Schedule (REV)	Overall Performance	Internal Phone / Fax	Internal In house confer meeting	Internal Email
Spearman's rho										
External In house confer meeting	.078	.051	.028	.083	.014	.055	.014	.057	.337**	.099
External Email	.269	.473	.696	.244	.847	.441	.844	.423	.000	.162
External Bulletin Board	.030	.074	.082	.063	-.047	.033	.055	.269**	.215**	.348**
External Newsgroup	.677	.301	.250	.376	.507	.646	.442	.000	.002	.000
External Intranet	-.085	.063	-.030	.107	-.072	-.020	-.012	.013	.116	-.018
External Extranet	.230	.372	.670	.130	.311	.779	.871	.854	.103	.797
External Instant Messaging	-.075	.077	-.033	.093	-.048	-.035	-.032	.037	.048	.021
External Webconferencing	.292	.278	.647	.190	.500	.618	.651	.602	.496	.767
External Commercialized	-.007	.046	.082	.082	.015	.027	-.071	.129	.128	.007
External Customized PDS	.922	.521	.250	.250	.828	.700	.316	.069	.071	.923
Value of this tool	-.072	.033	-.010	.038	-.030	-.015	-.014	.157*	.219**	.086
Integration: RD and Marketing	.309	.645	.883	.596	.670	.832	.845	.026	.002	.223
Integration: RD and Manufacturing	-.081	.057	-.075	.052	-.009	-.015	.078	.105	.128	.042
Integration: RD and Customer	.256	.420	.293	.463	.898	.832	.275	.139	.072	.555
Senior Level Involvement	-.050	.033	.063	.056	.020	.092	-.004	.095	.207**	.061
Integration: RD and Supplier	.483	.647	.379	.429	.778	.197	.954	.182	.003	.393
Integration: RD and Customer	-.106	.122	.002	.043	-.027	-.065	-.010	.019	.062	-.009
Integration: RD and Senior Level Involvement	.133	.084	.978	.543	.709	.358	.889	.785	.384	.901
Integration: RD and External Email	-.076	.132	.019	.048	-.049	-.019	.025	.065	.073	.029
Integration: RD and External Bulletin Board	.286	.063	.786	.504	.493	.786	.726	.361	.305	.682
Integration: RD and External Instant Messaging	-.062	.071	-.002	.142*	.075	.089	-.096	.003	.070	.199**
Integration: RD and External Webconferencing	.381	.314	.979	.045	.290	.208	.178	.966	.326	.005
Integration: RD and External Extranet	-.058	-.050	-.049	.065	.059	.095	-.076	.113	.079	.055
Integration: RD and External Newsgroup	.416	.482	.491	.359	.403	.181	.285	.110	.263	.439
Integration: RD and External Bulletin Board	-.141*	-.062	.029	.018	.055	.008	-.040	.143*	.175*	.111
Integration: RD and External Instant Messaging	.046	.384	.681	.796	.440	.906	.573	.044	.013	.118
Integration: RD and External Webconferencing	-.014	-.069	.102	.188**	.113	.167*	-.062	.081	.037	.119
Integration: RD and External Extranet	.842	.335	.150	.008	.110	.018	.382	.256	.599	.093
Integration: RD and External Newsgroup	.094	.053	.081	.061	.049	.043	-.013	.094	.136	.165*
Integration: RD and External Bulletin Board	.185	.457	.252	.392	.489	.546	.855	.184	.055	.019
Integration: RD and External Instant Messaging	.043	.019	.089	.107	-.005	.041	-.095	.145*	.128	.133
Integration: RD and External Webconferencing	.546	.793	.208	.131	.949	.561	.180	.041	.070	.060
Integration: RD and External Extranet	-.082	.089	.073	-.042	.094	.079	-.004	.092	.001	.092
Integration: RD and External Newsgroup	.249	.212	.303	.553	.184	.266	.952	.194	.986	.196

Correlations

Spearmant's rho	Internal Bulletin Board	Internal Newsgroup	Internal Intranet	Internal Extranet	Internal Instant Messaging	Internal Webconferencing	Internal Commercialized PDS	Internal Customized PDS	External Phone / Fax	External In house confer meeting
Size of the organization	-.135	-.101	.002	-.116	-.017	-.038	-.026	-.059	-.052	-.078
Complexity of product	.057	.157	.983	.102	.816	.589	.710	.407	.468	.269
Technical Success (rev)	.045	.070	.174*	.114	.085	.034	.124	.165*	.061	.051
Financial Success (rev)	.524	.327	.014	.108	.232	.637	.080	.019	.390	.473
Within Budget (REV)	.017	.027	.123	.014	-.059	.052	-.066	.024	.086	.028
On Schedule (REV)	.808	.705	.082	.846	.404	.463	.353	.733	.227	.696
Overall Performance	-.076	.010	.003	.024	.058	.084	.104	.052	.041	.083
Internal Phone / Fax	.287	.893	.967	.737	.418	.237	.144	.467	.566	.244
Internal In house confer meeting	-.060	-.055	.043	-.119	.032	.022	.072	.065	.024	.014
Internal Email	.398	.439	.548	.092	.649	.762	.309	.363	.740	.847
Internal Bulletin Board	-.052	-.029	.079	-.079	.026	.123	.011	.021	.070	.055
Internal Newsgroup	.465	.688	.267	.264	.718	.082	.875	.773	.325	.441
Internal Intranet	.032	-.035	-.129	.051	.076	-.081	.019	-.019	-.010	.014
Internal Extranet	.653	.618	.069	.473	.283	.256	.792	.786	.885	.844
Internal Instant Messaging	-.065	-.140*	.128	.100	.141*	.082	.111	.056	.238**	.057
Internal Webconferencing	.359	.048	.070	.160	.046	.251	.118	.434	.001	.423
Internal Commercialized PDS	.126	.014	.336**	.082	.136	.201**	.159*	.088	.184**	.337**
Internal Customized PDS	.075	.839	.000	.247	.055	.004	.024	.217	.009	.000
External Phone / Fax	.000	-.026	.294**	.020	.175*	.107	.104	.128	.211**	.099
External In house confer meeting	.997	.712	.000	.781	.013	.131	.144	.071	.003	.162
Internal Bulletin Board	1.000	.695**	.137	.395**	.334**	.393**	.280**	.278**	.175*	.287**
Internal Newsgroup	.695**	1.000	.217**	.500**	.243**	.416**	.320**	.391**	.127	.291**
Internal Intranet	.000	.000	.002	.000	.001	.000	.000	.000	.073	.000
Internal Extranet	.137	.217**	1.000	.390**	.237**	.289**	.311**	.312**	.267**	.321**
Internal Instant Messaging	.054	.002	.000	.000	.001	.000	.000	.000	.000	.000
Internal Webconferencing	.395**	.500**	.390**	1.000	.328**	.333**	.385**	.388**	.300**	.352**
Internal Commercialized PDS	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Internal Customized PDS	.334**	.243**	.237**	.328**	1.000	.457**	.257**	.348**	.248**	.374**
External Phone / Fax	.000	.001	.001	.000	.000	.000	.000	.000	.000	.000
External In house confer meeting	.393**	.416**	.289**	.333**	.457**	1.000	.355**	.396**	.207**	.375**
External Instant Messaging	.000	.000	.000	.000	.000	.000	.000	.000	.003	.000
External Webconferencing	.280**	.320**	.311**	.385**	.257**	.355**	1.000	.461**	.230**	.351**
External Commercialized PDS	.000	.000	.000	.000	.000	.000	.000	.000	.001	.000
External Customized PDS	.278**	.391**	.312**	.388**	.348**	.396**	.461**	1.000	.140*	.239**
External In house confer meeting	.000	.000	.000	.000	.000	.000	.000	.000	.047	.001
External Instant Messaging	.175*	.127	.267**	.300**	.248**	.207**	.230**	.140*	1.000	.594**
External Webconferencing	.013	.073	.000	.000	.000	.003	.001	.047	.000	.000

Correlations

	Internal Bulletin Board	Internal Newsgroup	Internal Intranet	Internal Extranet	Internal Instant Messaging	Internal Webconferencing	Internal Commercialized PDS	Internal Customized PDS	External Phone / Fax	External In house confer meeting
Spearman's rho										
External In house confer meeting	.287**	.291**	.321**	.352**	.374**	.375**	.351**	.239**	.594**	1.000
External Email	.000	.000	.000	.000	.000	.000	.000	.001	.000	.587**
External Bulletin Board	.164*	.182**	.330**	.378**	.301**	.279**	.296**	.187**	.736**	.000
External Newsgroup	.020	.010	.000	.000	.000	.000	.000	.008	.000	.326**
External Intranet	.565**	.691**	.212**	.408**	.300**	.502**	.348**	.410**	.155*	.000
External Extranet	.000	.000	.003	.000	.000	.000	.000	.000	.028	.000
External Instant Messaging	.540**	.717**	.192**	.419**	.311**	.492**	.368**	.424**	.177*	.327**
External Webconferencing	.000	.000	.007	.000	.000	.000	.000	.000	.012	.000
External Commercialized PDS	.481**	.499**	.316**	.398**	.377**	.512**	.389**	.375**	.246**	.454**
External Customized PDS	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Value of this tool	.253**	.384**	.410**	.561**	.269**	.324**	.357**	.300**	.304**	.461**
Integration: RD and Marketing	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Integration: Manufacturing	.441**	.427**	.215**	.413**	.587**	.436**	.394**	.292**	.292**	.424**
Integration: Supplier	.000	.000	.002	.000	.000	.000	.000	.000	.000	.000
Integration: Customer	.373**	.402**	.348**	.359**	.383**	.751**	.449**	.452**	.278**	.447**
Senior Level Involvement	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	.437**	.503**	.254**	.460**	.283**	.356**	.605**	.373**	.248**	.379**
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	.404**	.560**	.300**	.445**	.266**	.446**	.455**	.593**	.223**	.387**
	.000	.000	.000	.000	.000	.000	.000	.000	.002	.000
	.137	.196**	.300**	.263**	.274**	.387**	.207**	.351**	.100	.168**
	.052	.005	.000	.000	.000	.000	.003	.000	.158	.018
	.149*	.178*	.127	.129	.202**	.108	.248**	.074	.073	.104
	.036	.012	.073	.069	.004	.129	.000	.297	.303	.141
	.118	.091	.212**	.148*	.239**	.092	.220**	.248**	.084	.095
	.096	.202	.003	.036	.001	.193	.002	.000	.237	.182
	.219**	.212**	.132	.207**	.240**	.228**	.239**	.183**	.146*	.174**
	.002	.003	.062	.003	.001	.001	.001	.009	.038	.014
	.243**	.205**	.129	.230**	.273**	.212**	.230**	.171*	.270**	.369**
	.001	.004	.069	.001	.000	.003	.001	.015	.000	.000
	.111	.137	.154*	.125	.156*	.180*	.087	.101	.192**	.263**
	.117	.052	.030	.077	.028	.011	.219	.156	.007	.000
	.033	.001	.107	.076	.182*	.075	.060	.124	.098	.093
	.641	.987	.132	.288	.010	.294	.402	.081	.166	.189

Correlations

Spearman's rho	External Email	External Bulletin Board	External Newsgroup	External Intranet	External Extranet	External Instant Messaging	External Webconferencing	External Commercialized PDS	External Customized PDS	Value of this tool	Integration: RD and Manufacturing
	.030	-.085	-.075	-.007	-.072	-.081	-.050	-.106	-.076	-.062	-.058
Size of the organization	.677	.230	.292	.922	.309	.256	.483	.133	.286	.381	.416
Complexity of product	.074	.063	.077	.046	.033	.057	.033	.122	.132	.071	-.050
	.301	.372	.278	.521	.645	.420	.647	.084	.063	.314	.482
Technical Success (rev)	.082	-.030	-.033	.082	-.010	-.075	.063	.002	.019	-.002	-.049
	.250	.670	.647	.250	.883	.293	.379	.978	.786	.979	.491
Financial Success (rev)	.063	.107	.093	.082	.038	.052	.056	.043	.048	.142*	.065
	.376	.130	.190	.250	.596	.463	.429	.543	.504	.045	.359
Within Budget (REV)	-.047	-.072	-.048	.015	-.030	-.009	.020	-.027	-.049	.075	.059
	.507	.311	.500	.828	.670	.898	.778	.709	.493	.290	.403
On Schedule (REV)	.033	-.020	-.035	.027	-.015	-.015	.092	-.065	-.019	.089	.095
	.646	.779	.618	.700	.832	.832	.197	.358	.786	.208	.181
Overall Performance	.055	-.012	-.032	-.071	-.014	.078	-.004	-.010	.025	-.096	-.076
	.442	.871	.651	.316	.845	.275	.954	.889	.726	.178	.285
Internal Phone / Fax	.269**	.013	.037	.129	.157*	.105	.095	.019	.065	.003	.113
	.000	.854	.602	.069	.026	.139	.182	.785	.361	.966	.110
Internal in house confer meeting	.215**	.116	.048	.128	.219**	.128	.207**	.062	.073	.070	.079
	.002	.103	.496	.071	.002	.072	.003	.384	.305	.326	.263
Internal Email	.348**	-.018	.021	.007	.086	.042	.061	-.009	.029	.199**	.055
	.000	.797	.767	.923	.223	.555	.393	.901	.682	.005	.439
Internal Bulletin Board	.164*	.565**	.540**	.481**	.253**	.441**	.373**	.437**	.404**	.137	.149**
	.020	.000	.000	.000	.000	.000	.000	.000	.000	.052	.036
Internal Newsgroup	.182**	.691**	.717**	.499**	.384**	.427**	.402**	.503**	.560**	.196**	.178**
	.010	.000	.000	.000	.000	.000	.000	.000	.000	.005	.012
Internal Intranet	.330**	.212**	.192**	.316**	.410**	.215**	.348**	.254**	.300**	.300**	.127
	.000	.003	.007	.000	.000	.002	.000	.000	.000	.000	.073
Internal Extranet	.378**	.408**	.419**	.398**	.561**	.413**	.359**	.460**	.445**	.263**	.129
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.069
Internal Instant Messaging	.301**	.300**	.311**	.377**	.269**	.587**	.383**	.283**	.266**	.274**	.202**
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.004
Internal Webconferencing	.279**	.502**	.492**	.512**	.324**	.436**	.751**	.356**	.446**	.387**	.108
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.129
Internal Commercialized	.296**	.348**	.368**	.389**	.357**	.394**	.449**	.603**	.455**	.207**	.248**
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.003	.000
Internal Customized PDS	.187**	.410**	.424**	.375**	.300**	.292**	.452**	.373**	.593**	.351**	.074
	.008	.000	.000	.000	.000	.000	.000	.000	.000	.000	.297
External Phone / Fax	.736**	.155*	.177*	.246**	.304**	.292**	.278**	.248**	.223**	.100	.073
	.000	.028	.012	.000	.000	.000	.000	.000	.002	.158	.303

Correlations

	External Email	External Bulletin Board	External Newsgroup	External Intranet	External Extranet	External Instant Messaging	External Webconferencing	External Commercialized PDS	External Customized PDS	Value of this tool	Integration: RD and Manufacturing
Spearman's rho											
External In-house confer meeting	.587**	.326**	.327**	.454**	.461**	.424**	.447**	.379**	.387**	.168*	.104
External Email	.000	.000	.000	.000	.000	.000	.000	.000	.000	.018	.141
External Bulletin Board	1.000	.194**	.191**	.270**	.393**	.307**	.355**	.267**	.272**	.177*	.142*
External Newsgroup	.194**	.006	.007	.000	.000	.000	.000	.000	.000	.012	.045
External Intranet	.006	1.000	.902**	.646**	.457**	.566**	.562**	.539**	.646**	.186**	.121
External Extranet	.007	.000	1.000	.635**	.468**	.550**	.548**	.556**	.655**	.008	.088
External Instant Messaging	.007	.000	.000	.000	.000	.000	.000	.000	.000	.211**	.118
External Webconferencing	.270**	.646**	.635**	1.000	.465**	.545**	.630**	.569**	.630**	.249**	.125
External Commercialized PDS	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.077
External Customized PDS	.393**	.457**	.468**	.465**	1.000	.399**	.503**	.513**	.486**	.255**	.204**
Value of this tool	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.004
Integration: RD and Manufacturing	.307**	.566**	.550**	.545**	.399**	1.000	.489**	.515**	.470**	.211**	.173*
Integration: RD and Marketing	.000	.000	.000	.000	.000	.000	.000	1.000	.000	.003	.014
Integration: Manufacturing	.355**	.562**	.548**	.630**	.503**	.489**	1.000	.532**	.598**	.318**	.090
Integration- with Supplier	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.207
Integration- with Customer	.267**	.539**	.556**	.569**	.513**	.515**	.532**	1.000	.657**	.151*	.196**
Senior Level Involvement	.000	.000	.000	.000	.000	.000	.000	.657**	1.000	.032	.005
	.177*	.186**	.211**	.249**	.255**	.211**	.318**	.151*	.257**	1.000	.159*
	.012	.008	.003	.000	.000	.003	.000	.032	.000	.000	.024
	.142*	.121	.118	.125	.204**	.173*	.090	.196**	.177*	.159*	1.000
	.045	.088	.097	.077	.004	.014	.207	.005	.012	.024	.000
	.087	.101	.084	.067	.237**	.166*	.077	.228**	.107	.187**	.593**
	.222	.156	.237	.345	.001	.019	.277	.001	.132	.008	.000
	.204**	.171*	.142*	.238**	.167*	.196**	.170*	.191**	.192**	.189**	.627**
	.004	.015	.044	.001	.018	.005	.016	.007	.007	.007	.000
	.360**	.169**	.174*	.374**	.279**	.323**	.242**	.274**	.261**	.224**	.358**
	.000	.017	.014	.000	.000	.000	.001	.000	.000	.001	.000
	.247**	.150*	.153*	.266**	.243**	.229**	.230**	.162*	.224**	.172*	.272**
	.000	.035	.030	.000	.001	.001	.001	.022	.001	.015	.000
	.149*	-.009	-.007	.056	.086	.070	.111	.115	.054	.191**	.294**
	.035	.905	.927	.433	.228	.322	.117	.105	.444	.007	.000

Correlations

	Integration: RD and Marketing	Integration: Manufacturing and marketing	Integration- with Supplier	Integration- with Customer	Senior Level Involvement
Spearman's rho					
Size of the organization	-.141*	-.014	.094	.043	-.082
Complexity of product	.046	.842	.185	.546	.249
Technical Success (rev)	-.062	-.069	.053	.019	.089
Financial Success (rev)	.384	.335	.457	.793	.212
Within Budget (REV)	.029	.102	.081	.089	.073
On Schedule (REV)	.681	.150	.252	.208	.303
Overall Performance	.018	.188**	.061	.107	-.042
Internal Phone / Fax	.796	.008	.392	.131	.553
Internal In house confer meeting	.055	.113	.049	-.005	.094
Internal Email	.440	.110	.489	.949	.184
Internal Bulletin Board	.008	.167*	.043	.041	.079
Internal Newsgroup	.906	.018	.546	.561	.266
Internal Intranet	-.040	-.062	-.013	-.095	-.004
Internal Extranet	.573	.382	.855	.180	.952
Internal Instant Messaging	.143*	.081	.094	.145*	.092
Internal Webconferencing	.044	.256	.184	.041	.194
Commercialized Internal Customized PDS	.175*	.037	.136	.128	.001
External Phone / Fax	.013	.599	.055	.070	.986
	.111	.119	.165*	.133	.092
	.118	.093	.019	.060	.196
	.096	.219**	.243**	.111	.033
	.091	.002	.001	.117	.641
	.202	.212**	.205**	.137	.001
	.212**	.003	.004	.052	.987
	.003	.132	.129	.154*	.107
	.148*	.062	.069	.030	.132
	.036	.207**	.230**	.125	.076
	.239**	.003	.001	.077	.288
	.001	.240**	.273**	.156*	.182*
	.092	.001	.000	.028	.010
	.193	.228**	.212**	.180*	.075
	.220**	.001	.003	.011	.294
	.002	.239**	.230**	.087	.060
	.248**	.001	.001	.219	.402
	.000	.183**	.171*	.101	.124
	.084	.009	.015	.156	.081
	.237	.146*	.270**	.192**	.098
		.038	.000	.007	.166

Correlations

Spearman's rho	Integration: RD and Marketing	Integration: Manufacturing and marketing	Integration- with Supplier	Integration- with Customer	Senior Level Involvement
External In house confer meeting	.095	.174*	.369**	.263**	.093
External Email	.182	.014	.000	.000	.189
External Bulletin Board	.087	.204**	.360**	.247**	.149*
External Newsgroup	.222	.004	.000	.000	.035
External Intranet	.101	.171*	.169*	.150*	-.009
External Extranet	.156	.015	.017	.035	.905
External Instant Messaging	.084	.142*	.174*	.153*	-.007
External Webconferencing	.237	.044	.014	.030	.927
External Commercialized	.067	.238**	.374**	.266**	.056
External Customized PDS	.345	.001	.000	.000	.433
Value of this tool	.237**	.167*	.279**	.243**	.086
Integration: RD and Marketing	.166*	.196**	.323**	.229**	.070
Integration: Manufacturing and Marketing	.019	.005	.000	.001	.322
Integration- with Supplier	.077	.170*	.242**	.230**	.111
Integration- with Customer	.277	.016	.001	.001	.117
Senior Level Involvement	.228**	.191**	.274**	.162*	.115
Integration: RD and Marketing	.001	.007	.000	.022	.105
Integration: Manufacturing and Marketing	.107	.192**	.261**	.224**	.054
Integration- with Supplier	.132	.007	.000	.001	.444
Integration- with Customer	.187**	.189**	.224**	.172*	.191**
Senior Level Involvement	.008	.007	.001	.015	.007
Integration: RD and Marketing	.593**	.627**	.358**	.272**	.294**
Integration: Manufacturing and Marketing	.000	.000	.000	.000	.000
Integration- with Supplier	1.000	.550**	.411**	.314**	.410**
Integration- with Customer	.550**	.000	.000	.000	.000
Senior Level Involvement	.000	1.000	.464**	.341**	.331**
Integration: RD and Marketing	.411**	.464**	.000	.000	.000
Integration: Manufacturing and Marketing	.000	.000	1.000	.549**	.387**
Integration- with Supplier	.314**	.341**	.549**	1.000	.000
Integration- with Customer	.000	.000	.000	.000	.370**
Senior Level Involvement	.410**	.331**	.387**	.370**	1.000
Integration: RD and Marketing	.000	.000	.000	.000	.000

** . Correlation is significant at the .01 level (2-tailed).

* . Correlation is significant at the .05 level (2-tailed).

Appendix V: Significance matrix (nominal by nominal / ordinal variable)

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	q2_role	q3_size	q4_procd	q4_1_bu	q4_2_fir	q4_3_m	q4_4_sfl	q4_5_sy	q4_6_o	q5_com	q6_1te	q6_2fir	q6_3bu	q6_4sc	q6_5ovrat	q6_6tab
	N	O	N	N	N	N	N	N	N	O	O	O	O	O	O	N
Role of the project	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal
Size of the organization	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal
Type of Product	P=140	P=140	P=140	P=140	P=140	P=140	P=140	P=140	P=140	P=140	P=140	P=140	P=140	P=140	P=140	P=140
4 iq4_produ	Nominal	0.922	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5 iq4_1_bus	Nominal	0.604	0.000	-	-	-	-	-	-	-	-	-	-	-	-	-
6 iq4_2_fir	Nominal	0.474	0.000	0.003	-	-	-	-	-	-	-	-	-	-	-	-
7 iq4_3_mil	Nominal	0.698	0.000	0.000	0.586	-	-	-	-	-	-	-	-	-	-	-
8 iq4_4_shr	Nominal	0.261	0.000	0.016	0.697	1.000	-	-	-	-	-	-	-	-	-	-
9 iq4_5_sys	Nominal	0.326	0.000	0.059	0.258	1.000	0.224	-	-	-	-	-	-	-	-	-
10 iq4_6_oif	Nominal	0.819	0.000	0.000	1.000	0.045	0.211	0.775	-	-	-	-	-	-	-	-
11 iq5_compl	Ordinal	0.212	1.000	0.903	0.197	0.516	0.923	0.993	0.606	-	-	-	-	-	-	-
12 iq6_1tec	Ordinal	0.335	0.601	0.069	0.586	0.895	0.699	0.184	0.123	0.821	-	-	-	-	-	-
13 iq6_2fin	Ordinal	0.156	0.631	0.315	0.415	0.082	0.037	0.537	0.339	0.159	0.000	-	-	-	-	-
14 iq6_3bud	Ordinal	0.285	0.004	0.303	0.374	0.191	0.086	0.257	0.398	0.009	0.000	0.000	-	-	-	-
15 iq6_4sch	Ordinal	0.340	0.582	0.603	0.254	0.806	0.502	0.542	0.034	0.107	0.000	0.000	0.000	-	-	-
16 iq6_5ovrat	Ordinal	0.997	0.057	0.224	0.229	0.590	0.498	0.518	0.382	0.660	0.000	0.000	0.000	0.000	-	-
17 iq8_1abc	Nominal	0.315	0.500	0.329	0.328	0.287	0.079	0.396	0.802	0.531	0.855	0.334	0.002	0.038	0.376	-
18 iq8_2aps	Nominal	0.285	0.241	0.474	0.572	0.233	0.474	0.013	0.738	0.491	0.574	0.036	0.045	0.039	0.163	0.000
19 iq8_3csm	Nominal	0.125	0.174	0.657	0.265	0.557	0.033	0.128	0.662	0.201	0.544	0.566	0.028	0.634	0.954	0.000
20 iq8_4cm	Nominal	0.491	0.102	0.544	0.717	0.376	0.212	0.193	0.080	0.519	0.682	0.316	0.569	0.225	0.848	0.000
21 iq8_5crm	Nominal	0.430	0.232	0.098	0.548	0.613	0.098	0.583	0.347	0.085	0.234	0.535	0.642	0.077	0.489	0.000
22 iq8_6dw	Nominal	0.730	0.431	0.044	0.288	0.777	0.085	0.463	0.328	0.449	0.386	0.391	0.554	0.047	0.416	0.000
23 iq8_7ds	Nominal	0.745	0.240	0.950	0.607	0.566	0.619	0.020	0.419	0.173	0.070	0.106	0.021	0.739	0.345	0.000
24 iq8_8edi	Nominal	0.652	0.354	0.077	0.758	0.335	0.838	0.903	0.354	0.201	0.577	0.074	0.735	0.081	0.177	0.000
25 iq8_9erp	Nominal	0.615	0.257	0.554	0.693	0.122	0.222	0.517	0.671	0.131	0.122	0.174	0.016	0.011	0.366	0.000
26 iq8_10mel	Nominal	0.894	0.047	0.515	0.226	0.107	0.285	0.058	0.446	0.196	0.482	0.027	0.231	0.195	0.697	0.000
27 iq8_11om	Nominal	0.571	0.351	0.787	0.843	0.198	0.413	0.747	0.795	0.550	0.077	0.138	0.397	0.208	0.730	0.000
28 iq8_12pt	Nominal	0.326	0.129	0.627	0.600	0.183	0.497	0.323	0.968	0.859	0.003	0.067	0.034	0.025	0.001	0.000
29 iq8_13pd	Nominal	0.352	0.500	0.457	0.358	0.962	0.112	0.465	0.629	0.194	0.335	0.189	0.239	0.006	0.520	0.000
30 iq8_14wr	Nominal	0.691	0.344	0.488	0.782	0.574	0.115	0.422	0.577	0.751	0.647	0.009	0.133	0.277	0.475	0.000
31 iq9_1_ph	Ordinal	0.373	0.674	0.680	0.226	0.758	0.647	0.219	0.288	0.039	0.133	0.867	0.602	0.634	0.351	0.737
32 iq9_2_mel	Ordinal	0.008	0.632	0.659	0.362	0.209	0.548	0.407	0.284	0.173	0.476	0.745	0.531	0.698	0.321	0.029
33 iq9_3_emi	Ordinal	0.201	0.980	0.523	0.911	0.662	0.562	0.570	0.741	0.005	0.144	0.338	0.511	0.849	0.051	0.205
34 iq9_4_bu	Ordinal	0.056	0.198	0.110	0.185	0.345	0.085	0.153	0.642	0.494	0.797	0.284	0.374	0.453	0.664	0.190
35 iq9_5new	Ordinal	0.154	0.214	0.192	0.235	0.375	0.306	0.005	0.714	0.291	0.701	0.894	0.426	0.684	0.607	0.084
36 iq9_6int	Ordinal	0.976	0.673	0.882	0.541	0.053	0.546	0.778	0.327	0.013	0.080	0.965	0.527	0.273	0.058	0.013
37 iq9_7ext	Ordinal	0.106	0.101	0.491	0.014	0.039	0.981	0.059	0.409	0.100	0.852	0.731	0.088	0.280	0.488	0.007
38 iq9_8im	Ordinal	0.811	0.140	0.096	0.374	0.598	0.081	0.712	0.333	0.235	0.100	0.417	0.651	0.711	0.306	0.358
39 iq9_9web	Ordinal	0.586	0.195	0.345	0.504	0.867	0.052	0.158	0.674	0.615	0.463	0.234	0.790	0.085	0.256	0.001
40 iq9_10co	Ordinal	0.717	0.296	0.421	0.336	0.876	0.125	0.825	0.268	0.082	0.319	0.119	0.305	0.861	0.782	0.016
41 iq9_11cu	Ordinal	0.142	0.034	0.480	0.125	0.075	0.146	0.249	0.769	0.019	0.745	0.449	0.368	0.783	0.796	0.044
42 iq10_1ph	Ordinal	0.446	0.299	0.203	0.548	0.233	0.169	0.008	0.088	0.414	0.227	0.568	0.753	0.320	0.882	0.001
43 iq10_2mel	Ordinal	0.277	0.071	0.475	0.070	0.004	0.772	0.676	0.760	0.478	0.700	0.239	0.851	0.462	0.842	0.001
44 iq10_3eml	Ordinal	0.698	0.619	0.276	0.115	0.334	0.722	0.206	0.050	0.306	0.255	0.374	0.519	0.638	0.434	0.000
45 iq10_4bu	Ordinal	0.230	0.178	0.419	0.035	0.889	0.015	0.156	0.343	0.282	0.666	0.138	0.321	0.783	0.869	0.003
46 iq10_5ne	Ordinal	0.303	0.009	0.796	0.020	0.897	0.003	0.087	0.205	0.208	0.640	0.204	0.503	0.618	0.666	0.009
47 iq10_6in	Ordinal	0.908	0.155	0.914	0.181	0.781	0.165	0.113	0.201	0.502	0.256	0.255	0.828	0.703	0.326	0.001
48 iq10_7ex	Ordinal	0.303	0.016	0.369	0.019	0.262	0.828	0.007	0.055	0.618	0.882	0.591	0.668	0.826	0.845	0.003
49 iq10_8im	Ordinal	0.266	0.149	0.462	0.041	0.893	0.099	0.538	0.997	0.409	0.291	0.440	0.891	0.831	0.305	0.022
50 iq10_9we	Ordinal	0.652	0.495	0.749	0.261	0.872	0.028	0.030	0.716	0.604	0.370	0.426	0.777	0.209	0.952	0.000
51 iq10_10co	Ordinal	0.149	0.024	0.917	0.275	0.431	0.023	0.004	0.803	0.080	0.994	0.548	0.712	0.372	0.894	0.014
52 iq10_11cu	Ordinal	0.295	0.001	0.743	0.018	0.320	0.029	0.003	0.832	0.056	0.783	0.492	0.468	0.780	0.731	0.000

	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
	ncq8_2ap	ncq8_3csr	ncq8_4cfr	ncq8_5cfr	ncq8_6dwr	ncq8_7ds	ncq8_8edi	ncq8_9er	ncq8_10m	ncq8_11o	ncq8_12p	ncq8_13p	ncq8_14w	ncq9_1_p	ncq9_2_r	ncq9_3_e	ncq9_4_b	ncq9_5ne
	N	N	N	N	N	N	N	N	N	N	N	N	N	O	O	O	O	O
2	q2	role	Nominal															
3	q3	size	Ordinal															
4	q4	produ	Nominal															
5	q4	1_bus	Nominal															
6	q4	2_fir	Nominal															
7	q4	3_mil	Nominal															
8	q4	4_shr	Nominal															
9	q4	5_sys	Nominal															
10	q4	6_ofh	Nominal															
11	q5	compr	Ordinal															
12	ncq6	1fec	Ordinal															
13	ncq6	2fin	Ordinal															
14	ncq6	3bud	Ordinal															
15	ncq6	4sch	Ordinal															
16	ncq	rovral	Ordinal															
17	ncq8	1abc	Nominal															
18	ncq8	2aps	Nominal															
19	ncq8	3csm	Nominal	0.000														
20	ncq8	4cim	Nominal	0.000														
21	ncq8	5crm	Nominal	0.000														
22	ncq8	6dw	Nominal	0.000														
23	ncq8	7ds	Nominal	0.000														
24	ncq8	8edi	Nominal	0.000														
25	ncq8	9erp	Nominal	0.000														
26	ncq8	10me	Nominal	0.000														
27	ncq8	11om	Nominal	0.000														
28	ncq8	12pt	Nominal	0.000														
29	ncq8	13pd	Nominal	0.000														
30	ncq8	14wrn	Nominal	0.000														
31	ncq9	1_ph	Ordinal	0.336	0.822	0.706	0.090	0.118	0.684	0.369	0.245	0.480	0.896	0.025	0.283	0.218		
32	ncq9	2_me	Ordinal	0.043	0.028	0.158	0.020	0.338	0.183	0.056	0.002	0.236	0.031	0.000	0.009	0.001	0.000	
33	ncq9	3_em	Ordinal	0.077	0.118	0.468	0.046	0.290	0.161	0.062	0.053	0.216	0.387	0.000	0.127	0.237	0.000	
34	ncq9	4_bu	Ordinal	0.137	0.935	0.001	0.078	0.472	0.002	0.286	0.008	0.001	0.056	0.562	0.044	0.020	0.355	0.064
35	ncq9	5new	Ordinal	0.061	0.418	0.000	0.429	0.113	0.005	0.166	0.001	0.000	0.022	0.913	0.088	0.068	0.045	0.815
36	ncq9	6int	Ordinal	0.077	0.002	0.096	0.862	0.231	0.028	0.075	0.077	0.242	0.167	0.005	0.044	0.296	0.072	0.000
37	ncq9	7ext	Ordinal	0.153	0.014	0.012	0.507	0.042	0.000	0.001	0.312	0.006	0.297	0.255	0.118	0.022	0.146	0.214
38	ncq9	8im	Ordinal	0.009	0.422	0.001	0.011	0.079	0.000	0.270	0.001	0.024	0.174	0.417	0.159	0.074	0.036	0.049
39	ncq9	9web	Ordinal	0.028	0.002	0.000	0.018	0.035	0.001	0.017	0.000	0.000	0.018	0.086	0.001	0.000	0.232	0.002
40	ncq9	10cu	Ordinal	0.017	0.067	0.000	0.331	0.120	0.006	0.106	0.111	0.000	0.235	0.109	0.014	0.141	0.110	0.019
41	ncq9	11cu	Ordinal	0.436	0.217	0.000	0.282	0.540	0.011	0.275	0.018	0.001	0.394	0.225	0.054	0.030	0.379	0.192
42	ncq10	1ph	Ordinal	0.159	0.011	0.047	0.035	0.117	0.160	0.028	0.045	0.006	0.000	0.343	0.052	0.057	0.001	0.010
43	ncq10	2me	Ordinal	0.099	0.004	0.000	0.016	0.132	0.041	0.057	0.023	0.000	0.001	0.011	0.005	0.163	0.410	0.000
44	ncq10	3em	Ordinal	0.106	0.012	0.060	0.020	0.175	0.037	0.068	0.074	0.019	0.016	0.338	0.023	0.169	0.000	0.002
45	ncq10	4bu	Ordinal	0.325	0.057	0.001	0.022	0.454	0.001	0.156	0.000	0.000	0.000	0.079	0.856	0.236	0.006	0.846
46	ncq10	5ne	Ordinal	0.187	0.033	0.000	0.108	0.623	0.000	0.068	0.000	0.000	0.000	0.006	0.543	0.155	0.065	0.562
47	ncq10	6in	Ordinal	0.033	0.000	0.000	0.009	0.125	0.000	0.000	0.000	0.000	0.000	0.002	0.142	0.002	0.002	0.038
48	ncq10	7ex	Ordinal	0.093	0.013	0.001	0.162	0.156	0.002	0.033	0.099	0.000	0.088	0.027	0.069	0.647	0.019	0.001
49	ncq10	8im	Ordinal	0.211	0.038	0.000	0.304	0.696	0.000	0.028	0.008	0.005	0.057	0.010	0.015	0.137	0.107	0.056
50	ncq10	9we	Ordinal	0.016	0.001	0.000	0.001	0.005	0.000	0.003	0.000	0.000	0.002	0.116	0.001	0.000	0.159	0.001
51	ncq10	10co	Ordinal	0.014	0.006	0.000	0.331	0.335	0.014	0.315	0.099	0.001	0.128	0.071	0.086	0.035	0.789	0.373
52	ncq10	11cu	Ordinal	0.036	0.001	0.000	0.052	0.020	0.001	0.005	0.006	0.000	0.048	0.208	0.092	0.003	0.317	0.262

	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
	inq8_2ap	inq8_3csr	inq8_4cfr	inq8_5cfr	inq8_6dwr	inq8_7ds	inq8_8edf	inq8_9erf	inq8_10m	inq8_11a	inq8_12p	inq8_13p	inq8_14w	inq9_1_p	inq9_2_r	inq9_3_e	inq9_4_b	inq9_5me
	N	N	N	N	N	N	N	N	N	N	N	N	N	O	O	O	O	O
53 q11value	Ordinal	0.001	0.000	0.020	0.001	0.214	0.101	0.007	0.000	0.276	0.019	0.010	0.021	0.896	0.328	0.002	0.060	0.005
54 q121sour	Nominal	0.212	0.395	0.397	0.263	0.906	0.195	0.139	0.385	0.233	0.309	0.184	0.603	0.055	0.595	0.015	0.589	0.294
55 q12 2	Nominal	0.036	0.000	0.493	0.086	0.001	0.634	0.225	0.028	0.057	0.030	0.011	0.553	0.442	0.497	0.161	0.286	0.156
56 q12 3	Nominal	0.675	0.158	0.558	0.031	0.162	0.335	0.210	0.531	0.257	0.020	0.116	0.653	0.548	0.836	0.307	0.116	0.253
57 q12 4	Nominal	0.579	0.074	0.043	0.002	0.027	0.138	0.080	0.437	0.484	0.015	0.207	0.287	0.408	0.159	0.940	0.502	0.648
58 q12 5	Nominal	0.042	0.039	0.034	0.025	0.046	0.182	0.028	0.052	0.208	0.185	0.177	0.694	0.593	0.433	0.747	0.892	0.094
59 q12 6	Nominal	0.249	0.543	0.015	0.592	0.138	0.684	0.097	0.753	0.637	0.069	0.192	0.700	0.400	0.615	0.866	0.030	0.102
60 q12 7	Nominal	0.421	0.923	0.199	0.485	0.808	0.774	0.201	0.310	0.215	0.808	0.751	0.599	0.865	0.720	0.768	0.651	0.790
61 q12 8	Nominal	0.281	0.009	0.315	0.270	0.010	0.405	0.087	0.154	0.008	0.010	0.112	0.660	0.365	0.620	0.094	0.694	0.687
62 q12 9	Nominal	0.644	0.309	0.095	0.423	0.160	0.820	0.191	0.625	0.151	0.063	0.266	0.265	0.355	0.659	0.611	0.131	0.135
63 q12 10	Nominal	0.578	0.009	0.189	0.322	0.100	0.169	0.016	0.752	0.725	0.099	0.059	0.324	0.926	0.814	0.562	0.904	0.029
64 q12 11	Nominal	0.547	0.486	0.390	0.325	0.141	0.439	0.225	0.960	0.960	0.143	0.007	0.971	0.176	0.100	0.880	0.463	0.334
65 q12 12	Nominal	0.395	0.408	0.665	0.764	0.212	0.778	0.252	0.410	0.657	0.727	0.803	0.552	0.179	0.137	0.937	0.713	0.792
66 q12 13	Nominal	0.053	0.016	0.181	0.003	0.029	0.079	0.011	0.009	0.840	0.001	0.004	0.159	0.002	0.817	0.000	0.747	0.156
67 q13 1pmi	Nominal	0.097	0.006	0.156	0.004	0.158	0.840	0.047	0.060	0.806	0.381	0.357	0.094	0.116	0.523	0.021	0.454	0.665
68 q13 2pro	Nominal	0.033	0.027	0.019	0.100	0.456	0.952	0.004	0.023	0.020	0.033	0.132	0.062	0.640	0.249	0.103	0.176	0.029
69 q13 3	Nominal	0.148	0.141	0.717	0.438	0.063	0.425	0.023	0.657	0.194	0.196	0.015	0.009	0.446	0.408	0.189	0.736	0.645
70 q13 4	Nominal	0.708	0.593	0.869	0.095	0.194	0.529	0.026	0.005	0.051	0.955	0.465	0.520	0.635	0.930	0.054	0.743	0.406
71 q13 5	Nominal	0.431	0.072	0.057	0.501	0.658	0.058	0.653	0.690	0.010	0.234	0.738	0.582	0.430	0.510	0.138	0.210	0.277
72 q13 6	Nominal	0.999	0.413	0.110	0.506	0.615	0.019	0.958	0.300	0.620	0.515	0.498	0.290	0.749	0.288	0.287	0.036	0.226
73 q13 7	Nominal	0.053	0.025	0.540	0.511	0.860	0.768	0.092	0.110	0.280	0.358	0.477	0.402	0.431	0.033	0.579	0.128	0.020
74 q13 8	Nominal	0.114	0.020	0.002	0.138	0.630	0.885	0.439	0.467	0.012	0.335	0.331	0.498	0.072	0.033	0.080	0.322	0.033
75 q13 9	Nominal	0.052	0.026	0.340	0.293	0.127	0.740	0.308	0.089	0.082	0.029	0.201	0.465	0.514	0.189	0.499	0.826	0.005
76 q13 10	Nominal	0.002	0.013	0.070	0.033	0.037	0.006	0.005	0.034	0.047	0.244	0.016	0.039	0.291	0.829	0.467	0.094	0.108
77 q14 1ada	Nominal	0.049	0.255	0.129	0.124	0.006	0.144	0.060	0.249	0.035	0.055	0.068	0.131	0.264	0.119	0.303	0.346	0.429
78 q14 2	Nominal	0.542	0.823	0.874	0.816	0.089	0.339	0.395	0.553	0.626	0.434	0.970	0.963	0.558	0.546	0.188	0.217	0.927
79 q14 3	Nominal	0.043	0.044	0.162	0.320	0.123	0.403	0.351	0.271	0.175	0.596	0.463	0.760	0.060	0.720	0.001	0.134	0.000
80 q14 4	Nominal	0.342	0.567	0.415	0.183	0.312	0.701	0.282	0.490	0.918	0.370	0.454	0.365	0.063	0.635	0.562	0.667	0.219
81 q14 5	Nominal	0.503	0.337	0.053	0.611	0.148	0.317	0.730	0.972	0.195	0.518	0.171	0.094	0.904	0.147	0.595	0.897	0.157
82 q14 6	Nominal	0.246	0.137	0.082	0.076	0.605	0.374	0.127	0.046	0.260	0.431	0.233	0.749	0.535	0.160	0.531	0.276	0.374
83 q14 7	Nominal	0.512	0.479	0.019	0.006	0.009	0.141	0.095	0.337	0.751	0.154	0.270	0.587	0.075	0.647	0.371	0.217	0.992
84 q14 8	Nominal	0.723	0.067	0.585	0.780	0.901	0.233	0.383	0.605	0.803	0.431	0.434	0.767	0.839	0.300	0.455	0.329	0.273
85 q14 9	Nominal	0.064	0.596	0.870	0.060	0.165	0.677	0.016	0.802	0.882	0.461	0.159	0.277	0.364	0.428	0.586	0.991	0.533
86 q14 10	Nominal	0.021	0.023	0.833	0.033	0.194	0.776	0.030	0.450	0.834	0.192	0.073	0.330	0.222	0.143	0.282	0.141	0.940
87 q14 11	Nominal	0.245	0.023	0.926	0.043	0.272	0.561	0.005	0.525	0.029	0.027	0.036	0.177	0.414	0.141	0.594	0.647	0.104
88 q14 12	Nominal	0.002	0.002	0.014	0.001	0.020	0.029	0.000	0.005	0.047	0.005	0.001	0.006	0.517	0.052	0.614	0.043	0.055
89 q15 1	Ordinal	0.000	0.000	0.000	0.010	0.028	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.103	0.272	0.396	0.025	0.005
90 q15 2	Ordinal	0.001	0.000	0.000	0.000	0.066	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.045	0.014	0.119	0.086	0.161
91 q15 3	Ordinal	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.245	0.602	0.066	0.001	0.002
92 q15 4	Ordinal	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.182	0.056	0.008	0.000	0.003
93 q15 5	Ordinal	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.043	0.084	0.070	0.098	0.041
94 q15 6	Ordinal	0.007	0.015	0.065	0.000	0.001	0.008	0.020	0.019	0.296	0.015	0.000	0.073	0.229	0.997	0.199	0.635	0.998

	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
	nq9_6int	nq9_7ext	nq9_8im	nq9_9we	nq9_10c	nq9_11c	nq10_1p	nq10_2m	nq10_3e	nq10_4b	nq10_5n	nq10_6ir	nq10_7e	nq10_8ir	nq10_9w	nq10_10cc	nq10_11c	q11value
2	q2	role	Nominal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	q3	size	Ordinal															
4	q4	produ	Nominal															
5	q4_1	bus	Nominal															
6	q4_2	fir	Nominal															
7	q4_3	mil	Nominal															
8	q4_4	shr	Nominal															
9	q4_5	sys	Nominal															
10	q4_6	oth	Nominal															
11	q5	compi	Ordinal															
12	inq6_1	tec	Ordinal															
13	inq6_2	fin	Ordinal															
14	inq6_3	bud	Ordinal															
15	inq6_4	sch	Ordinal															
16	inq/ovral		Ordinal															
17	inq8_1	abc	Nominal															
18	inq8_2	aps	Nominal															
19	inq8_3	scsm	Nominal															
20	inq8_4	cim	Nominal															
21	inq8_5	orm	Nominal															
22	inq8_6	ow	Nominal															
23	inq8_7	ds	Nominal															
24	inq8_8	edi	Nominal															
25	inq8_9	erp	Nominal															
26	inq8_10	me	Nominal															
27	inq8_11	om	Nominal															
28	inq8_12	pt	Nominal															
29	inq8_13	pd	Nominal															
30	inq8_14	wrr	Nominal															
31	inq9_1	ph	Ordinal															
32	inq9_2	mel	Ordinal															
33	inq9_3	eml	Ordinal															
34	inq9_4	bu	Ordinal															
35	inq9_5	new	Ordinal															
36	inq9_6	int	Ordinal															
37	inq9_7	ext	Ordinal	0.000														
38	inq9_8	im	Ordinal	0.001	0.000													
39	inq9_9	web	Ordinal	0.000	0.000	0.000												
40	inq9_10	co	Ordinal	0.000	0.000	0.000	0.000											
41	inq9_11	cu	Ordinal	0.000	0.000	0.000	0.000											
42	inq10_1	ph	Ordinal	0.000	0.000	0.002	0.001	0.041										
43	inq10_2	me	Ordinal	0.000	0.000	0.000	0.001	0.000										
44	inq10_3	em	Ordinal	0.000	0.000	0.000	0.005	0.000										
45	inq10_4	bu	Ordinal	0.000	0.000	0.000	0.015	0.000	0.001									
46	inq10_5	ne	Ordinal	0.002	0.000	0.000	0.004	0.000	0.001	0.000								
47	inq10_6	in	Ordinal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000							
48	inq10_7	ex	Ordinal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000						
49	inq10_8	im	Ordinal	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000					
50	inq10_9	we	Ordinal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
51	inq10_10	co	Ordinal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			
52	inq10_11	cu	Ordinal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	
	mq9_6int	mq9_7ext	mq9_8im	mq9_9we	mq9_10c	mq9_11c	mq10_1p	mq10_2m	mq10_3e	mq10_4b	mq10_5n	mq10_6in	mq10_7e	mq10_8in	mq10_9w	mq10_10c	mq10_11c	q1value	
	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
53 q11value	0.000	0.000	0.000	0.000	0.002	0.000	0.154	0.021	0.010	0.008	0.003	0.000	0.000	0.004	0.000	0.031	0.000	-	
54 q121sour	0.006	0.027	0.144	0.008	0.025	0.001	0.615	0.213	0.333	0.278	0.268	0.258	0.488	0.640	0.125	0.528	0.070	0.127	
55 q12 2	Nominal	0.164	0.565	0.381	0.695	0.306	0.166	0.515	0.145	0.096	0.139	0.161	0.191	0.670	0.691	0.796	0.259	0.043	
56 q12 3	Nominal	0.229	0.800	0.249	0.271	0.749	0.140	0.420	0.058	0.022	0.106	0.701	0.371	0.934	0.763	0.563	0.597	0.012	
57 q12 4	Nominal	0.616	0.806	0.494	0.298	0.194	0.723	0.376	0.616	0.450	0.404	0.649	0.147	0.164	0.457	0.482	0.462	0.091	
58 q12 5	Nominal	0.041	0.158	0.210	0.069	0.603	0.109	0.162	0.019	0.014	0.130	0.095	0.011	0.775	0.170	0.232	0.015	0.000	
59 q12 6	Nominal	0.549	0.480	0.716	0.773	0.552	0.770	0.064	0.237	0.220	0.611	0.436	0.211	0.823	0.456	0.110	0.357	0.966	
60 q12 7	Nominal	0.239	0.120	0.006	0.198	0.504	0.765	0.818	0.539	0.357	0.140	0.410	0.109	0.537	0.271	0.712	0.137	0.339	
61 q12 8	Nominal	0.001	0.291	0.310	0.031	0.243	0.504	0.754	0.101	0.017	0.207	0.982	0.047	0.834	0.629	0.781	0.381	0.001	
62 q12 9	Nominal	0.535	0.065	0.004	0.131	0.421	0.527	0.067	0.782	0.040	0.001	0.001	0.024	0.368	0.002	0.540	0.436	0.136	
63 q12 10	Nominal	0.031	0.246	0.249	0.711	0.228	0.059	0.184	0.094	0.142	0.039	0.556	0.326	0.768	0.063	0.098	0.005	0.131	
64 q12 11	Nominal	0.010	0.253	0.494	0.237	0.879	0.489	0.369	0.465	0.617	0.439	0.468	0.783	0.593	0.639	0.802	0.710	0.016	
65 q12 12	Nominal	0.759	0.601	0.627	0.609	0.634	0.625	0.677	0.531	0.875	0.881	0.817	0.617	0.810	0.626	0.480	0.225	0.155	
66 q12 13	Nominal	0.016	0.077	0.120	0.009	0.450	0.006	0.091	0.003	0.231	0.257	0.477	0.029	0.361	0.031	0.768	0.166	0.000	
67 q13 1pmi	Nominal	0.119	0.873	0.202	0.054	0.350	0.596	0.236	0.046	0.052	0.148	0.228	0.069	0.525	0.189	0.151	0.431	0.001	
68 q13 2pro	Nominal	0.001	0.024	0.034	0.006	0.647	0.083	0.430	0.180	0.005	0.029	0.054	0.012	0.076	0.051	0.323	0.138	0.000	
69 q13 3	Nominal	0.013	0.366	0.480	0.093	0.235	0.478	0.498	0.512	0.144	0.335	0.170	0.014	0.096	0.089	0.835	0.147	0.001	
70 q13 4	Nominal	0.032	0.696	0.000	0.001	0.388	0.453	0.182	0.208	0.138	0.224	0.058	0.480	0.200	0.007	0.545	0.035	0.006	
71 q13 5	Nominal	0.457	0.006	0.263	0.000	0.018	0.177	0.016	0.255	0.005	0.013	0.000	0.033	0.106	0.000	0.061	0.036	0.013	
72 q13 6	Nominal	0.358	0.084	0.098	0.025	0.216	0.446	0.493	0.151	0.773	0.000	0.036	0.111	0.027	0.075	0.312	0.298	0.515	
73 q13 7	Nominal	0.133	0.215	0.008	0.034	0.014	0.044	0.007	0.078	0.673	0.672	0.270	0.043	0.070	0.051	0.161	0.002	0.003	
74 q13 8	Nominal	0.590	0.518	0.180	0.059	0.267	0.946	0.056	0.439	0.127	0.193	0.002	0.918	0.629	0.017	0.431	0.477	0.574	
75 q13 9	Nominal	0.438	0.182	0.000	0.020	0.118	0.103	0.051	0.066	0.183	0.002	0.041	0.044	0.022	0.000	0.254	0.001	0.001	
76 q13 10	Nominal	0.370	0.093	0.255	0.005	0.043	0.172	0.195	0.207	0.193	0.194	0.168	0.081	0.605	0.060	0.269	0.252	0.000	
77 q14 1ada	Nominal	0.293	0.122	0.081	0.082	0.385	0.043	0.283	0.013	0.287	0.765	0.584	0.027	0.289	0.228	0.262	0.131	0.956	
78 q14 2	Nominal	0.281	0.036	0.223	0.361	0.965	0.201	0.007	0.205	0.549	0.623	0.412	0.409	0.781	0.575	0.212	0.267	0.705	
79 q14 3	Nominal	0.008	0.004	0.051	0.349	0.211	0.023	0.001	0.001	0.002	0.005	0.003	0.010	0.590	0.016	0.023	0.045	0.777	
80 q14 4	Nominal	0.774	0.454	0.211	0.643	0.334	0.901	0.311	0.270	0.463	0.169	0.581	0.230	0.374	0.847	0.667	0.648	0.079	
81 q14 5	Nominal	0.366	0.428	0.261	0.517	0.522	0.051	0.030	0.042	0.013	0.002	0.048	0.375	0.223	0.160	0.338	0.027	0.968	
82 q14 6	Nominal	0.580	0.965	0.065	0.605	0.662	0.047	0.167	0.428	0.577	0.433	0.769	0.796	0.245	0.927	0.319	0.162	0.777	
83 q14 7	Nominal	0.822	0.741	0.149	0.554	0.979	0.743	0.856	0.108	0.905	0.870	0.920	0.309	0.388	0.812	0.639	0.645	0.207	
84 q14 8	Nominal	0.866	0.094	0.450	0.580	0.829	0.771	0.352	0.410	0.009	0.001	0.623	0.155	0.026	0.782	0.103	0.038	0.426	
85 q14 9	Nominal	0.435	0.831	0.155	0.625	0.833	0.153	0.166	0.185	0.431	0.493	0.511	0.581	0.783	0.389	0.457	0.541	0.444	
86 q14 10	Nominal	0.382	0.320	0.880	0.074	0.765	0.876	0.203	0.652	0.419	0.728	0.375	0.775	0.217	0.081	0.371	0.643	0.214	
87 q14 11	Nominal	0.061	0.263	0.269	0.118	0.411	0.757	0.103	0.230	0.010	0.012	0.102	0.008	0.096	0.031	0.170	0.083	0.029	
88 q14 12	Nominal	0.192	0.046	0.319	0.046	0.518	0.099	0.173	0.048	0.304	0.170	0.249	0.067	0.845	0.410	0.865	0.405	0.043	
89 q15 1	Ordinal	0.072	0.062	0.003	0.127	0.000	0.296	0.135	0.041	0.063	0.077	0.055	0.002	0.008	0.201	0.003	0.009	0.023	
90 q15 2	Ordinal	0.002	0.033	0.000	0.182	0.002	0.243	0.174	0.236	0.131	0.209	0.317	0.000	0.011	0.255	0.001	0.121	0.008	
91 q15 3	Ordinal	0.058	0.003	0.000	0.001	0.009	0.035	0.013	0.003	0.015	0.050	0.001	0.014	0.005	0.017	0.007	0.007	0.008	
92 q15 4	Ordinal	0.072	0.001	0.000	0.002	0.001	0.000	0.000	0.000	0.018	0.016	0.000	0.000	0.000	0.001	0.000	0.000	0.000	
93 q15 5	Ordinal	0.032	0.074	0.019	0.009	0.210	0.010	0.000	0.001	0.027	0.024	0.000	0.000	0.000	0.001	0.017	0.001	0.017	
94 q15 6	Ordinal	0.123	0.294	0.008	0.281	0.399	0.177	0.187	0.033	0.900	0.918	0.415	0.200	0.309	0.109	0.115	0.437	0.004	

	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
	q121sou	q12_2	q12_3	q12_4	q12_5	q12_6	q12_7	q12_8	q12_9	q12_10	q12_11	q12_12	q12_13	q13_1p	q13_2p	q13_3	q13_4	q13_5	q13_6	q13_7	q13_8	q13_9
	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
2	q2	role	Nominal																			
3	q3	size	Ordinal																			
4	q4	produ	Nominal																			
5	q4_1	bus	Nominal																			
6	q4_2	fir	Nominal																			
7	q4_3	mil	Nominal																			
8	q4_4	shr	Nominal																			
9	q4_5	sys	Nominal																			
10	q4_6	oth	Nominal																			
11	q5	compi	Ordinal																			
12	inq6_1	tec	Ordinal																			
13	inq6_2	fin	Ordinal																			
14	inq6_3	bud	Ordinal																			
15	inq6_4	sch	Ordinal																			
16	inq/ovral		Ordinal																			
17	inq8_1	abc	Nominal																			
18	inq8_2	aps	Nominal																			
19	inq8_3	scsm	Nominal																			
20	inq8_4	cim	Nominal																			
21	inq8_5	orm	Nominal																			
22	inq8_6	dw	Nominal																			
23	inq8_7	ds	Nominal																			
24	inq8_8	edi	Nominal																			
25	inq8_9	erp	Nominal																			
26	inq8_10	me	Nominal																			
27	inq8_11	om	Nominal																			
28	inq8_12	pt	Nominal																			
29	inq8_13	pd	Nominal																			
30	inq8_14	wrr	Nominal																			
31	inq9_1	ph	Ordinal																			
32	inq9_2	me	Ordinal																			
33	inq9_3	em	Ordinal																			
34	inq9_4	bu	Ordinal																			
35	inq9_5	new	Ordinal																			
36	inq9_6	int	Ordinal																			
37	inq9_7	ext	Ordinal																			
38	inq9_8	im	Ordinal																			
39	inq9_9	web	Ordinal																			
40	inq9_10	cco	Ordinal																			
41	inq9_11	cu	Ordinal																			
42	inq10_1	ph	Ordinal																			
43	inq10_2	me	Ordinal																			
44	inq10_3	em	Ordinal																			
45	inq10_4	bu	Ordinal																			
46	inq10_5	ne	Ordinal																			
47	inq10_6	in	Ordinal																			
48	inq10_7	ex	Ordinal																			
49	inq10_8	im	Ordinal																			
50	inq10_9	we	Ordinal																			
51	inq10_10	cco	Ordinal																			
52	inq10_11	cu	Ordinal																			

	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	
	q121sour	q12_2	q12_3	q12_4	q12_5	q12_6	q12_7	q12_8	q12_9	q12_10	q12_11	q12_12	q12_13	q13_1p	q13_2p	q13_3	q13_4	q13_5	q13_6	q13_7	q13_8	q13_9	
	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal	Ordinal
53 q11value																							
54 q121sour																							
55 q12 2	0.001																						
56 q12 3	0.029	0.000																					
57 q12 4	0.009	0.000	0.067																				
58 q12 5	0.016	0.000	0.000																				
59 q12 6	0.564	0.073	0.257	0.000	0.117																		
60 q12 7	0.077	0.713	0.153	0.423	0.215	0.422																	
61 q12 8	0.015	0.000	0.000	0.000	0.000	0.400	1.000																
62 q12 9	0.405	1.000	1.000	0.646	0.347	0.335	0.001	0.013															
63 q12 10	0.049	0.007	0.181	0.331	0.003	1.000	1.000	0.002	0.133														
64 q12 11	0.066	0.085	0.000	0.002	0.001	0.759	0.000	0.387	0.351														
65 q12 12	1.000	1.000	0.562	1.000	1.000	1.000	1.000	0.616	1.000	0.320	0.240												
66 q12 13	0.000	0.000	0.000	0.000	0.000	0.132	0.357	0.000	0.592	0.017	0.000	1.000											
67 q13 1pmi	0.000	0.000	0.000	0.000	0.001	0.563	0.472	0.000	0.404	0.081	0.000	1.000	0.000										
68 q13 2pro	0.000	0.010	0.036	0.065	0.000	0.770	0.154	0.000	0.200	0.041	0.001	0.557	0.000	0.000									
69 q13 3	0.002	0.000	0.000	0.006	0.000	0.579	0.025	0.000	0.004	0.004	0.050	0.595	0.000	0.000	0.000								
70 q13 4	0.023	0.003	0.000	0.003	0.264	0.389	0.149	0.004	0.099	0.828	0.034	0.598	0.000	0.000	0.000	0.000							
71 q13 5	1.000	0.491	0.316	1.000	1.000	1.000	0.303	0.324	0.025	0.079	0.277	1.000	1.000	0.707	0.300	0.306	0.308						
72 q13 6	1.000	0.749	0.345	1.000	1.000	1.000	0.154	0.064	0.764	0.291	0.625	1.000	1.000	0.532	0.336	1.000	0.758						
73 q13 7	0.583	0.012	0.137	0.002	0.001	0.470	0.157	0.000	0.073	0.394	0.331	1.000	0.051	0.003	0.001	0.001	0.000	0.011	0.114				
74 q13 8	0.605	0.107	0.600	0.032	0.041	0.279	0.127	0.037	0.075	0.108	0.279	1.000	0.480	0.191	0.056	0.197	0.201	0.003	0.047	0.002			
75 q13 9	0.495	0.050	0.298	0.031	0.022	1.000	0.377	0.006	1.000	0.000	0.719	0.527	0.064	0.026	0.001	0.060	0.001	0.004	0.067	0.001	0.000		
76 q13 10	0.007	0.018	0.003	0.004	0.132	0.132	0.357	0.000	0.592	0.138	0.025	0.420	0.000	0.000	0.000	0.000	0.000	0.360	0.217	0.001	0.079	0.019	
77 q14 1ada	0.120	0.750	0.343	0.378	0.385	1.000	0.244	0.646	1.000	0.234	0.409	0.556	0.300	0.061	0.166	0.063	0.759	1.000	0.511	1.000	0.571	0.192	
78 q14 2	0.103	1.000	0.321	1.000	0.731	0.131	0.004	0.748	1.000	1.000	1.000	0.374	0.745	0.745	0.043	0.518	0.193	1.000	0.097	1.000	0.574	0.231	
79 q14 3	0.293	1.000	0.714	0.116	0.215	0.010	1.000	0.491	0.220	0.599	0.440	1.000	0.357	0.284	0.773	1.000	0.727	0.044	0.064	0.637	0.127	0.688	
80 q14 4	0.016	0.824	0.024	0.210	0.809	0.658	0.247	0.666	0.540	0.745	0.820	1.000	0.017	0.194	0.041	0.275	0.004	1.000	0.131	0.155	1.000	0.188	
81 q14 5	0.612	0.037	0.006	0.021	0.039	0.181	0.388	0.007	1.000	0.799	0.072	0.546	0.012	0.001	0.024	0.028	0.132	0.687	1.000	0.312	0.211	0.002	
82 q14 6	0.504	0.647	0.256	0.311	0.327	1.000	0.231	0.378	1.000	1.000	0.814	1.000	1.000	1.000	0.065	0.181	0.075	0.602	1.000	0.040	1.000	0.599	
83 q14 7	0.401	0.225	0.172	0.130	1.000	0.508	1.000	0.472	1.000	0.454	0.592	1.000	0.266	0.011	0.038	0.094	0.184	0.688	0.464	0.133	0.538	0.547	
84 q14 8	1.000	0.612	0.503	1.000	0.363	1.000	0.682	0.420	1.000	0.138	1.000	0.575	1.000	0.620	0.867	0.518	0.870	1.000	0.472	0.094	0.553	0.074	
85 q14 9	0.607	0.284	0.113	0.028	0.051	0.036	0.373	0.390	0.344	1.000	0.269	0.518	0.486	0.168	0.007	0.085	0.009	0.209	0.463	0.509	0.344	0.000	
86 q14 10	0.404	0.004	0.020	0.008	0.103	0.690	0.295	0.148	1.000	0.106	0.074	1.000	0.010	0.209	0.063	0.539	0.407	0.106	0.647	0.107	0.241	0.005	
87 q14 11	0.020	0.000	0.000	0.000	0.000	0.773	0.064	0.000	0.688	0.007	0.014	1.000	0.000	0.600	0.000	0.000	0.000	1.000	0.760	0.060	0.000	0.015	
88 q14 12	0.037	0.011	0.001	0.001	0.003	0.074	0.208	0.025	0.347	0.032	0.457	0.009	0.001	0.000	0.007	0.000	0.058	1.000	0.125	0.042	0.026	0.408	
89 q15 1	0.570	0.011	0.850	0.063	0.258	0.450	0.358	0.042	0.906	0.007	0.305	0.084	0.492	0.281	0.002	0.266	0.371	0.100	0.862	0.029	0.191	0.226	
90 q15 2	0.267	0.454	0.945	0.035	0.461	0.516	0.497	0.666	0.994	0.662	0.247	0.164	0.350	0.563	0.105	0.715	0.478	0.055	0.977	0.272	0.833	0.771	
91 q15 3	0.478	0.257	0.899	0.005	0.040	0.592	0.802	0.307	0.188	0.220	0.992	0.136	0.424	0.274	0.372	0.853	0.938	0.014	0.282	0.234	0.027	0.191	
92 q15 4	0.213	0.296	0.201	0.001	0.000	0.636	0.820	0.098	0.802	0.548	0.920	0.700	0.064	0.089	0.130	0.919	0.066	0.803	0.074	0.005	0.269	0.101	
93 q15 5	0.945	0.182	0.176	0.038	0.021	0.555	0.404	0.240	0.505	0.563	0.030	0.041	0.040	0.085	0.050	0.403	0.154	0.642	0.333	0.326	0.365	0.014	
94 q15 6	0.418	0.005	0.001	0.011	0.090	0.932	0.478	0.012	0.327	0.757	0.309	0.507	0.000	0.173	0.073	0.231	0.039	0.076	0.681	0.010	0.688	0.764	

	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
	q13_10	q14_1a	q14_2	q14_3	q14_4	q14_5	q14_6	q14_7	q14_8	q14_9	q14_10	q14_11	q14_12	q15_1	q15_2	q15_3	q15_4	q15_5	q15_6
	N	N	N	N	N	N	N	N	N	N	N	N	N	O	O	O	O	O	O
2	q2_role																		
3	q3_size																		
4	q4_produ																		
5	q4_1_bus																		
6	q4_2_fir																		
7	q4_3_mil																		
8	q4_4_shr																		
9	q4_5_sys																		
10	q4_6_ofh																		
11	q5_compl																		
12	q6_1tec																		
13	q6_2fin																		
14	q6_3bud																		
15	q6_4sch																		
16	q7_ovral																		
17	q8_1abc																		
18	q8_2aps																		
19	q8_3csm																		
20	q8_4cim																		
21	q8_5crm																		
22	q8_6dw																		
23	q8_7ds																		
24	q8_8bedi																		
25	q8_9erp																		
26	q8_10me																		
27	q8_11om																		
28	q8_12pt																		
29	q8_13pd																		
30	q8_14wrr																		
31	q9_1_ph																		
32	q9_2_me																		
33	q9_3_eml																		
34	q9_4_bu																		
35	q9_5new																		
36	q9_6int																		
37	q9_7ext																		
38	q9_8im																		
39	q9_9web																		
40	q9_10co																		
41	q9_11cu																		
42	q10_1ph																		
43	q10_2me																		
44	q10_3em																		
45	q10_4bu																		
46	q10_5ne																		
47	q10_6in																		
48	q10_7ex																		
49	q10_8im																		
50	q10_9we																		
51	q10_10co																		
52	q10_11cu																		

Appendix VI: Cramer's V matrix among fourteen IT systems

(ABC, APS, CSM, CIM, CRM, Data warehousing, Design systems, EDI, ERP, MES, OMS, PTS, PDM, WMS)

		ABC	APS	CSM	CIM	CRM	DW	DS	EDI	ERP	MES	OMS	PTS	PDM	WMS
ABC	Cramer's V	1.000													
	Sig. (2-tailed)														
APS	Cramer's V	.532	1.000												
	Sig. (2-tailed)	.000													
CSM	Cramer's V	.540	.513	1.000											
	Sig. (2-tailed)	.000	.000												
CIM	Cramer's V	.466	.511	.523	1.000										
	Sig. (2-tailed)	.000	.000	.000											
CRM	Cramer's V	.451	.489	.447	.455	1.000									
	Sig. (2-tailed)	.000	.000	.000	.000										
DW	Cramer's V	.419	.469	.452	.423	.520	1.000								
	Sig. (2-tailed)	.000	.000	.000	.000	.000									
DS	Cramer's V	.390	.450	.473	.509	.372	.434	1.000							
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000								
EDI	Cramer's V	.460	.500	.453	.443	.529	.510	.457	1.000						
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000							
ERP	Cramer's V	.515	.527	.487	.562	.493	.471	.470	.533	1.000					
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000						
MES	Cramer's V	.462	.450	.498	.593	.411	.399	.474	.450	.546	1.000				
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.001	.000	.000	.000					
OMS	Cramer's V	.487	.496	.524	.526	.507	.485	.406	.522	.569	.523	1.000			
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000				
PTS	Cramer's V	.398	.491	.442	.392	.511	.465	.412	.504	.502	.417	.549	1.000		
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.001	.000			
PDM	Cramer's V	.488	.467	.477	.466	.531	.525	.429	.533	.522	.481	.551	.650	1.000	
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		
WMS	Cramer's V	.456	.491	.476	.546	.511	.554	.410	.530	.531	.546	.585	.496	.638	1.000
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	

** Cramer's V is significant at the .01 level (2-tailed).

Appendix VII: InsightExpress web-centric survey snapshot

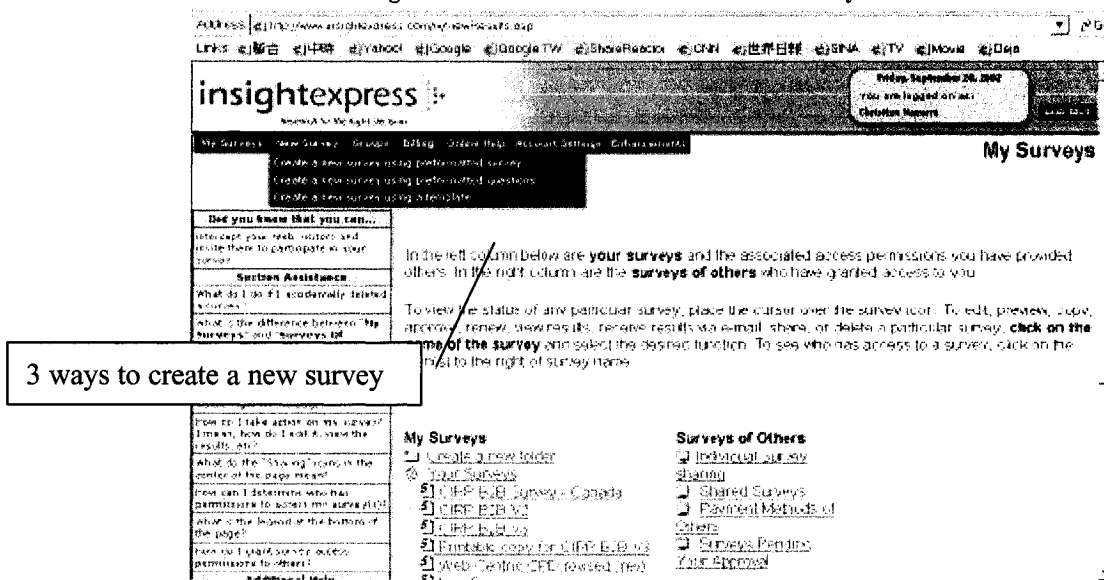
In this section, the procedure of on-line survey through *InsightExpress* is briefly introduced. For detailed information about web-centric survey, please visit <http://www.insightexpress.com/>.

Step 1: Create a new survey

There are three ways to create a new survey:

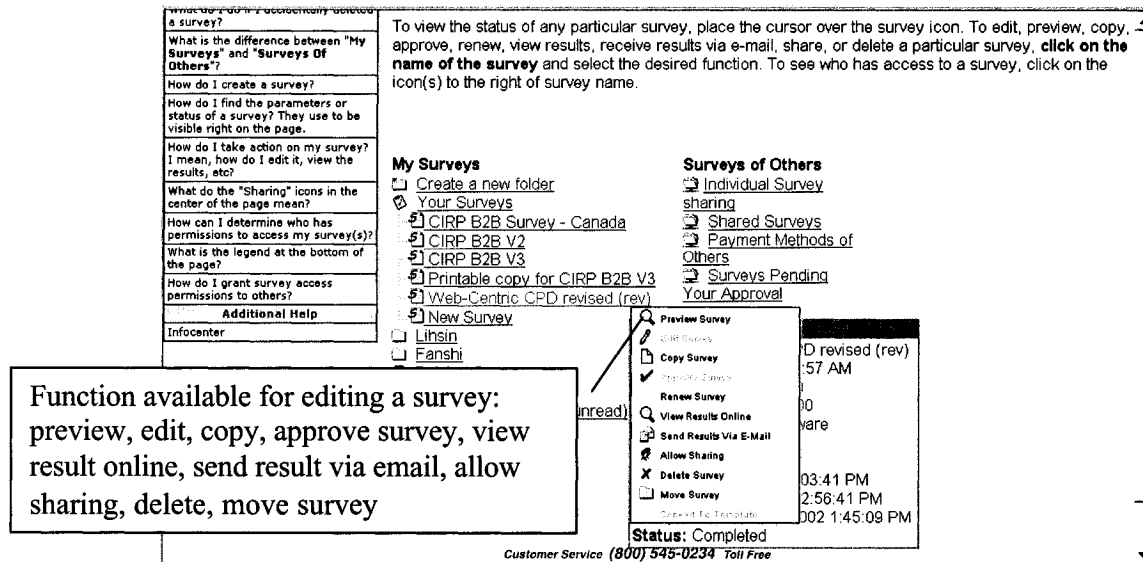
- Create a new survey using preformatted survey
- Create a new survey using preformatted questions
- Create a new survey using a template

Figure A- 52: Screenshot: create a new survey



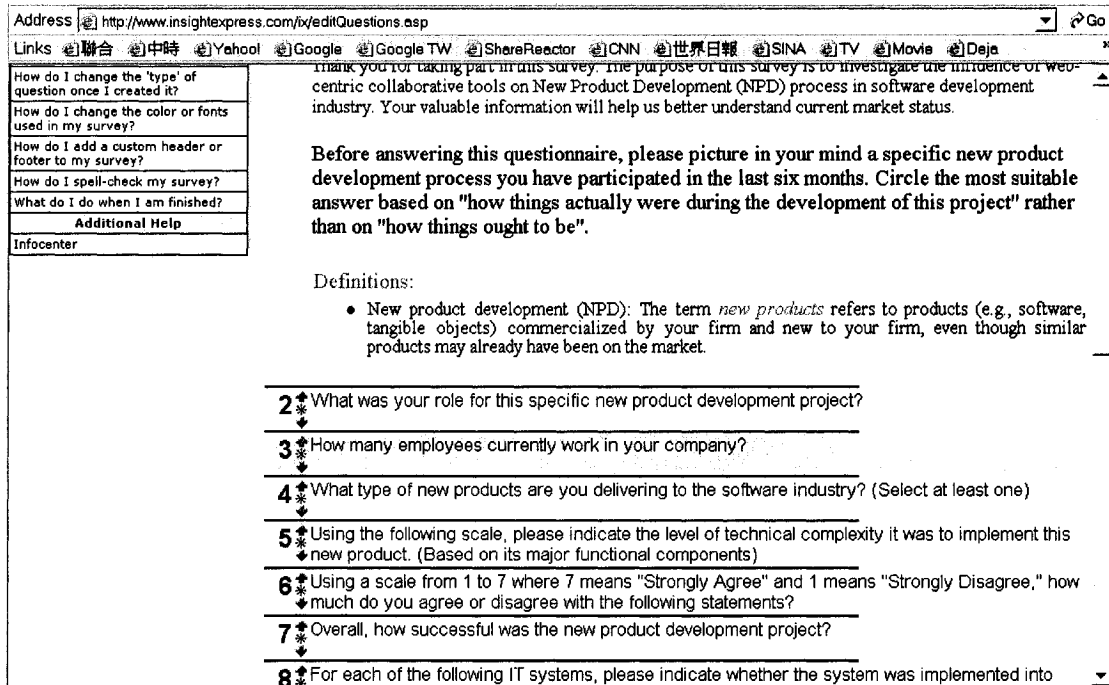
Step 2: Design, edit a survey

Figure A- 53: Screenshot: survey-editing options



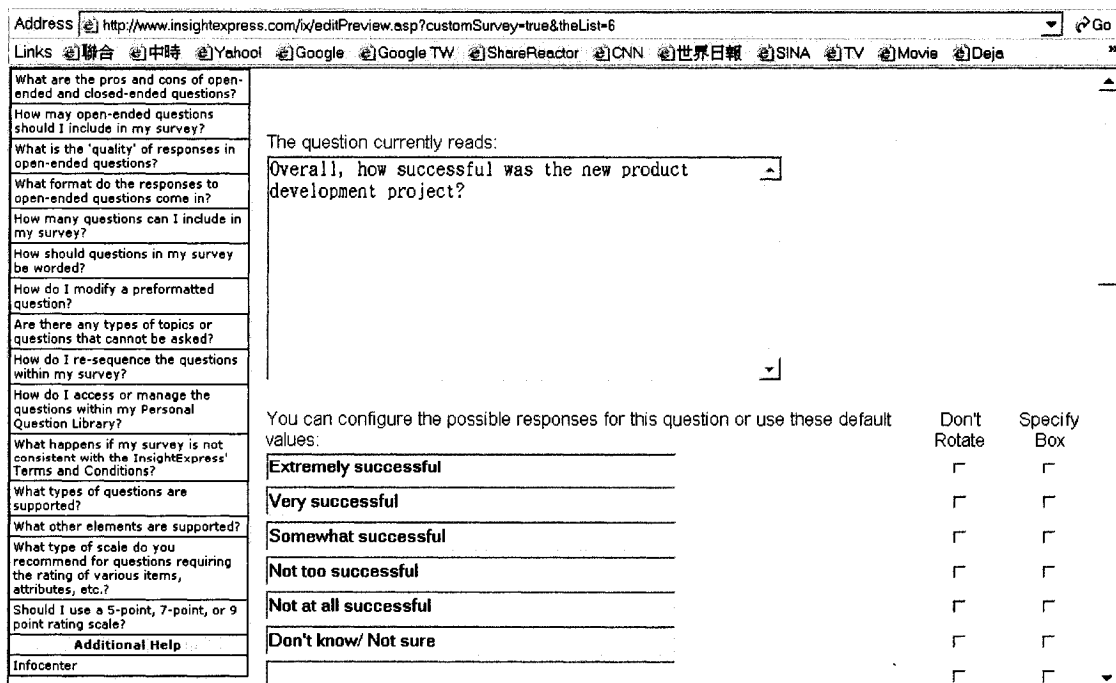
Step 3: Survey editing process 1: choose a question to edit

Figure A- 54: Screenshot: edit a questionnaire



Step 4: Survey editing process 2: Enter the editing screen. There are different types of questions. Therefore, each type of questions will have different type of format of editing.

Figure A- 55: Screenshot: edit a question



Step 5: Preview and then add the question. The following screenshot presents the outcome from preview survey editing screenshot.

Figure A- 56: Screenshot: preview a question

The question as the respondents will view it:

1. Overall, how successful was the new product development project?

- Extremely successful
- Very successful
- Somewhat successful
- Not too successful
- Not at all successful
- Don't know/ Not sure

Include a copy of this question in my Personal Question Library

Step 6: Complete all required questions and preview the questionnaire

Figure A- 57: Screenshot: preview the complete questionnaire

Done with preview

1. **Web-centric Collaborative Product Development Survey**

Thank you for taking part in this survey. The purpose of this survey is to investigate the influence of web-centric collaborative tools on New Product Development (NPD) process in software development industry. Your valuable information will help us better understand current market status.

Before answering this questionnaire, please picture in your mind a specific new product development process you have participated in the last six months. Circle the most suitable answer based on "how things actually were during the development of this project" rather than on "how things ought to be".

Definitions:

- New product development (NPD): The term *new products* refers to products (e.g., software, tangible objects) commercialized by your firm and new to your firm, even though similar products may already have been on the market.

Done Internet

Step 7: After completing all the questions, submit it for approval. The survey will be officially launched to panel respondents once it has been approved.

Figure A- 58: Screenshot: submit for approval

Groups, how do I select which group I would like to use with my survey?

If I create multiple invitations, how do I select which I would like to use with my survey?

How long does it take to approve a survey?

How soon will I see results?

Can I make changes to a survey after it has been finalized and submitted?

What can be done if I discover a mistake in the questionnaire after it has already been submitted to respondents?

Once I have completed my survey, how do I submit it?

How will I know when my survey starts?

How will I know when my survey is complete?

Will I receive invoices for my surveys?

Additional Help

InfoCenter

surveys submitted outside of normal customer service hours, may be delayed until normal customer service hours resume. InsightExpress customer services hours are Monday through Friday 8am - 8pm eastern standard time.

Please review these considerations before approving your survey

Submit my survey to InsightExpress

Please note that approved surveys cannot be changed.

Survey Details:

Name: Web-Centric CPD revised
 Target Audience: Software Dev/Computer Mgmt
 Target Completes: 200
 Pay with: Purchase Order: 1/25/02 (Balance: \$262.50)
 Survey Price: \$4,750.00
 Create Date: 4/1/2002 11:11:30 AM

Step 8: Upon completion of target completes (for this research, the target completes are 200 completes), researchers can easily access to the results on line or send the results to specific email address. To view the results on line, click on “view result online” from Figure A-2.

Figure A- 59: Screenshot: view result on-line

How should the results from InsightExpress be used?

How will open-ended responses be provided?

How do I interpret the results of my survey?

Can I get some assistance from you on interpreting my results?

Additional Help

InfoCenter

Trend results using: Trending Options

All Data

Filter results using: Filtering Options

Summary Report
Reporting Options
Drop Analysis

Browse Responses

6. Using the following scale, how much do you agree or disagree with each of ...

7. Overall, how successful was the new product development project?

8. For each of the following IT systems, please indicate whether the system i...

9. How?often did you exchange project information internally (with other proj...

10. How often did you exchange project information externally (with customers/...

11. Based on the definition of "collaborative tools", was there any web-based ...

12. Based on your experience, please identify the following benefits of collab...

13. Describe the purpose of the collaborative tool you used for this project. ...

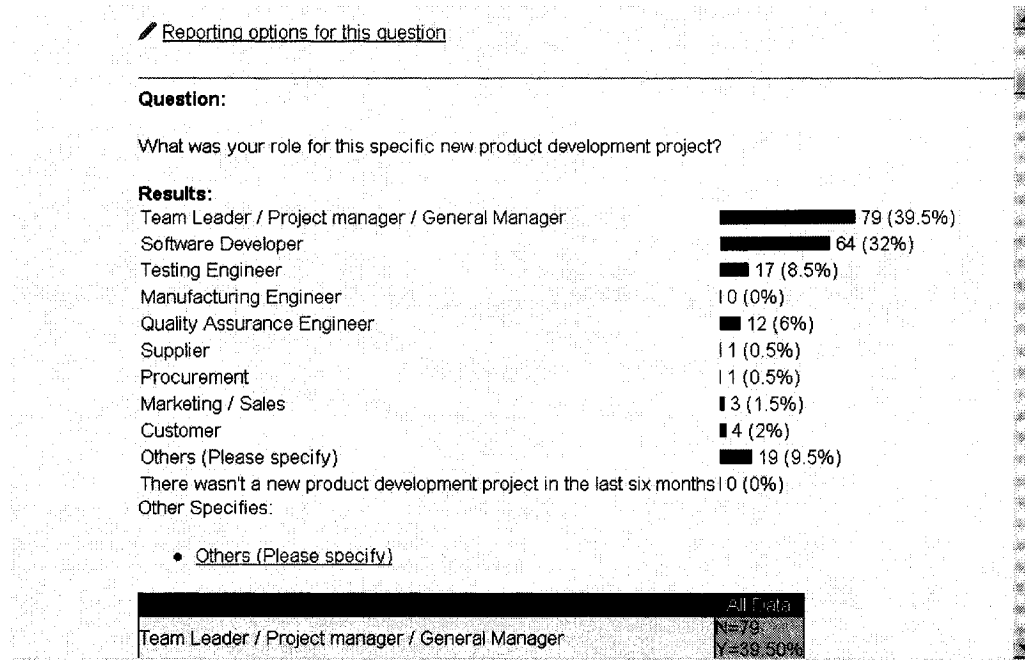
14. Which of the following obstacles and resistances?describe?your?web-based c...

15. Using the following scale, please rate the degree of integration with each...

View Selected Questions

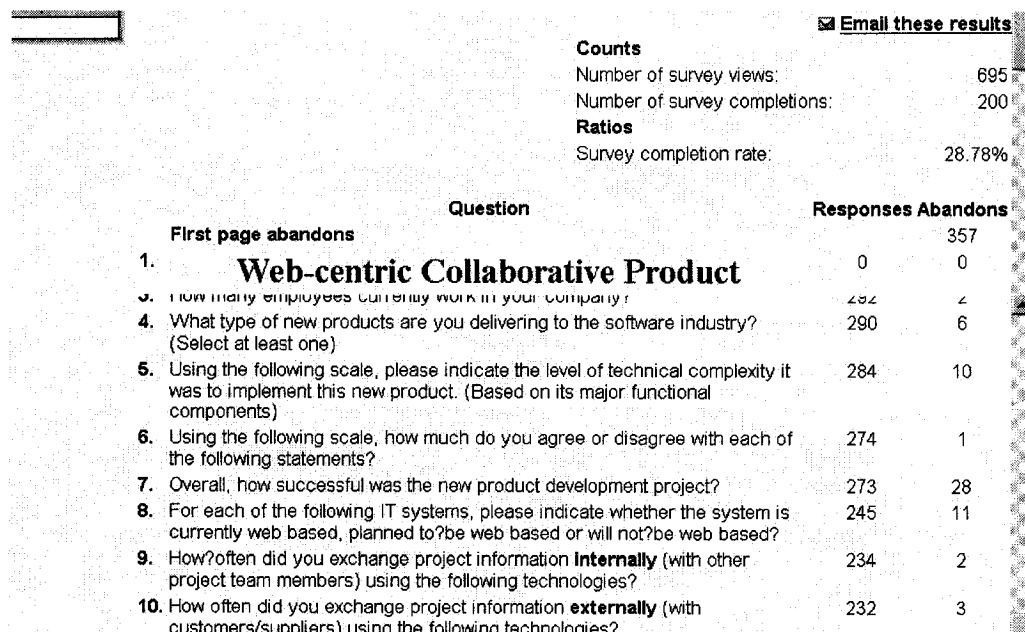
Step 9: There are three options available for reviewing results on line. The first one is “Summary Report”. The researcher can modify the way of representing dataset by click on “Reporting options” from Figure A-8. The researcher can get a brief summary of each question for the questionnaire.

Figure A- 60: Screenshot: view result online - summary report



Step 10: The second option for reviewing results online is “Drop Analysis”. It provides the number of responses for each question separately.

Figure A- 61: Screenshot: view result online- drop analysis



Step 11: Or, researcher can also review raw data by “browse responses”. The researcher can browse each response one by one or delete invalid responses.

Figure A- 62: Screenshot: review result online - browse responses

<input type="checkbox"/>	Software Developer	Fewer than 50	<ul style="list-style-type: none"> Others (Please specify) 	6	Very successful	Neither valuable nor not valuable
<input type="checkbox"/>	Others (Please specify)	More than 2,500	<ul style="list-style-type: none"> Others (Please specify) 	4	Not too successful	Valuable

Step 12: The results can also be sent via email. To send the results via email, click on “Send results via email” from Figure A-2.

Responses:

What should I do if I do not receive my results via e-mail?

What will the data look like when I receive it?

How do I obtain the underlying data?

[Additional Help](#)

Infocenter

Select how you would like to receive your results as well as any additional options for this email. You can elect to have only a subset of your data delivered to you or data for all respondents, but only for some of your questions.

Email Results
Partial Data
Partial Questions

Obtain your results in Microsoft Excel complete with charts, tables, and cross-tabulation capabilities (recommended for surveys with less than 20 questions and less than 1000 completions)

Obtain the raw respondent level data with a codebook to help you interpret the results (recommended for large surveys or to import into third-party data processing or statistical packages)

Column Delimiter: Send my results to these email addresses:

1.
2.
3.
4.
5.

Back to my surveys
Get Results

Appendix VIII: List of "Others" from the result of the questionnaire

Question 2: *What was your role for this specific new product development project?*

Technical writer/documentation (4)	It support (2)
Internal product / database specialist	Product strategy
Configuration management/release management	Designer
Database administrator (2)	Functional analyst
Systems/network administrator	Security
Developer & marketing (2)	It infrastructure
Resource management	Junior project manager

Question 4: *What type of new products are you delivering to the software industry?*

Semiconductor manufacturer	Web site
Space exploration software	Web conferencing
Wireless mobile access/multimedia	Gaming software
Telecommunications	Healthcare
Telecom network products	Games
Edms & document lifecycle management (2)	Collaboration software
Web-based instructional, other web	Government
Application service provider, self-hosted web tool	Various
E-procurement software	Training software
Dynamic web applications	School software
Research software	E-books
Aerospace software - space exploration (2)	Intelligent systems

Question 12: *Based on your experience, please identify the following benefits of collaborative product development tools.*

Saved face to face meetings which usually waste	Reduced duplication of effort
Enabled remote tech support	

Question 13: *Describe the purpose of the collaborative tools you used for this project*

We just have custom web tool for bugs and features	Did not use (21)
Transfer real time data	Bug tracking
Source code exchange	CM
Source Code Control	Track errors
Testing results, test plans, Q&A	Did not use for this project
System requirement tracking	

Question 14: *Which of the following obstacles and resistances describe your web-based collaborative product development systems?*

Lack of Validation to 21CFR11	Microsoft's idiocy
Product wasn't web based	Wrong target market
The technology isn't reliable.	Requires network resources
Too many bells and whistles	Can't answer this
There were no obstacles or resistance (3)	Unknown
Software limitation for number of users	N/A (5)
Current System has minimal web interface	None (10)
No web-based collaborative product (5)	

Appendix IV: The output of factor analysis for overall project performance

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	11.619	27.665	27.665	8.633	20.555	20.555
2	6.304	15.009	42.675	5.297	12.600	33.155
3	3.025	7.203	49.877	5.010	11.929	45.084
4	2.894	6.890	56.767	2.946	7.015	52.099
5	2.445	5.822	62.590	2.348	5.590	57.689
6	1.959	4.665	67.255	2.222	5.290	62.979
7	1.931	4.599	71.853	2.174	5.176	68.156
8	1.598	3.806	75.659	1.846	4.395	72.550
9	1.429	3.403	79.062	1.668	3.973	76.523
10	1.307	3.112	82.174	1.592	3.790	80.313
11	1.192	2.837	85.012	1.588	3.781	84.094
12	1.141	2.717	87.728	1.526	3.634	87.728
13	.757	1.803	89.532			
14	.735	1.750	91.282			
15	.662	1.576	92.858			
16	.535	1.273	94.131			
17	.477	1.135	95.266			
18	.442	1.053	96.319			
19	.370	.882	97.200			
20	.300	.715	97.915			
21	.247	.588	98.504			
22	.192	.457	98.961			
23	.149	.355	99.315			
24	.122	.290	99.605			
25	8.079E-02	.192	99.798			
26	6.118E-02	.146	99.944			
27	2.372E-02	5.648E-02	100.000			
28	1.222E-15	2.909E-15	100.000			
29	5.099E-16	1.214E-15	100.000			
30	3.139E-16	7.474E-16	100.000			
31	1.993E-16	4.745E-16	100.000			
32	1.274E-16	3.033E-16	100.000			
33	4.221E-17	1.005E-16	100.000			
34	2.669E-17	-6.355E-17	100.000			
35	6.257E-17	-1.490E-16	100.000			
36	9.958E-17	-2.371E-16	100.000			
37	2.354E-16	-5.604E-16	100.000			
38	2.821E-16	-6.716E-16	100.000			
39	3.545E-16	-8.441E-16	100.000			
40	3.843E-16	-9.151E-16	100.000			
41	5.225E-16	-1.244E-15	100.000			
42	7.037E-16	-1.676E-15	100.000			

Extraction Method: Principal Component Analysis.

a. Only cases for which Overall performance (Rev) = Extremely successful are used in the anal

Rotated Component Matrix^a

	Component								
	1	2	3	4	5	6	7	8	9
NO8 3CSM	.878			.180		-.138	.113		.203
NO8 12PT	.825				.254	.131	-.192	-.125	-.110
NO8 2APS	.827	.138	.277	.187	.137	-.177	-.108		.274
NO8 6 DW	.820					-.101		.159	-.241
NO8 13PD	.803				.136	.288			-.185
NO8 14WM	.802			-.207			.191	.143	-.302
NO8 4CIM	.797		.294	.134	.110		.234	.152	.120
NO8 9ERP	.789		.206	-.311		-.108			
NO8 11OM	.775	.204		.199	-.278				-.257
NO8 10ME	.740	.158	.133	.168	-.215		.194	.199	
NO8 8EDI	.721	.126		.232		.300		-.128	.265
NO8 1ABC	.656	.176	.274	.208	.219	-.453	-.108	.127	.212
NO8 5CRM	.616	-.119	.179	.254	-.114	.367	.110		-.178
NO8 7 DS	.555	.204	.307	.166		-.231		.315	
NO10 5NE		.904	.297						
NO9 5NEW		.877	.343				.127		
NO10 4BU	.230	.852	.331						
NO9 4 BU		.803	.263	-.225			.117		
NO9 11CU		.659	.303	.303		.381			
NO1011CU	.193	.655	.241	.260	.211	.381	.136	.136	
NO9 7EXT	.169	.573		.312	-.278		.384		
NO10 8IM	.117	.316	.878				.133	-.106	
NO10 6IN	.145	.250	.859	.140		-.171	.147		
NO10 9WE	.236	.176	.812			.179	.280		
NO9 9WEB	.185	.302	.802	-.103		.156		-.216	
NO9 8IM			.705	.177			-.219	.404	.135
NO10 2ME	.211	.194	.572	.437	.319			.241	.202
NO10 7EX		.344	.410	.374	.355	-.343	-.360		.230
NO10 1PH	.174			.878			.166	.254	
NO10_3EM	.107		.175	.871			.139		-.136
NO9 6INT	.126				.844		.142		-.140
NO9 2 ME		.125	.379		.678	.346	-.126	.142	
O5 CPLX						.905	.188		
NO9 10CO	.127	.239	.181	.273	.118	.267	.773		
NO1010CO		.300	.375	.140			.754	.109	
O4 3 MIL								-.926	
O4 6 OTH	-.118		.124	-.153	-.108				.887
NO9 1 PH				.180		.111		.120	
O4 1 BUS	-.123	.389		-.123	.158		-.140	.235	-.345
O4 5 SYS			.151		.351		-.153	.195	-.125
O4 4 SHR	.120	-.323	-.117	.231	.159		.154	-.142	
O4 2 FIR	-.236	-.186			.498	-.324	.296		

Extraction Method: Principal Component Analysis.
 Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 19 iterations.

b. Only cases for which Overall performance (Rev) = Extremely successful are used in the analysis phase.

Appendix V: The output of factor analysis for organizational (schedule) project performance

Total Variance Explained^a

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	14.247	33.927	33.927	8.761	20.859	20.859
2	5.163	12.292	46.214	7.228	17.210	38.069
3	3.805	9.059	55.273	4.008	9.543	47.612
4	2.155	5.131	60.404	3.535	8.418	56.029
5	2.063	4.912	65.316	2.378	5.663	61.692
6	2.004	4.773	70.088	2.263	5.389	67.082
7	1.678	3.995	74.084	2.085	4.963	72.045
8	1.507	3.589	77.672	1.849	4.402	76.447
9	1.275	3.035	80.707	1.789	4.260	80.707
10	.988	2.352	83.059			
11	.931	2.217	85.276			
12	.870	2.072	87.348			
13	.822	1.958	89.305			
14	.746	1.775	91.081			
15	.630	1.500	92.581			
16	.538	1.282	93.863			
17	.455	1.082	94.945			
18	.397	.945	95.890			
19	.335	.798	96.688			
20	.275	.654	97.343			
21	.234	.558	97.901			
22	.181	.430	98.331			
23	.169	.404	98.735			
24	.139	.330	99.064			
25	.116	.275	99.340			
26	9.502E-02	.226	99.566			
27	6.727E-02	.160	99.726			
28	5.807E-02	.138	99.864			
29	3.324E-02	7.915E-02	99.944			
30	1.953E-02	4.651E-02	99.990			
31	4.141E-03	9.858E-03	100.000			
32	1.059E-15	2.520E-15	100.000			
33	6.474E-16	1.542E-15	100.000			
34	2.524E-16	6.011E-16	100.000			
35	2.439E-16	5.807E-16	100.000			
36	1.427E-16	3.398E-16	100.000			
37	5.055E-17	1.203E-16	100.000			
38	1.239E-17	2.951E-17	100.000			
39	9.780E-17	-2.329E-16	100.000			
40	3.356E-16	-7.991E-16	100.000			
41	3.563E-16	-8.483E-16	100.000			
42	8.672E-16	-2.065E-15	100.000			

Extraction Method: Principal Component Analysis.

a. Only cases for which On Schedule (REV) = 5 are used in the analysis phase.

Rotated Component Matrix^a

	Component								
	1	2	3	4	5	6	7	8	9
NO8 14WM	.838	.209		.139		.168			.223
NO8 7 DS	.815	.146		.223			-.138		.262
NO8 4CIM	.814	.216	.179			.297	.184		
NO8 2APS	.771				-.254	.198		-.317	
NO8 1ABC	.748	.195			-.196	-.246	-.193	.114	-.253
NO8 13PD	.747	.277		.376	.154	.195			.212
NO8 11OM	.744	.276	.319			.206	.350		
NO8 8EDI	.743	.286		.319	.272				.142
NO8 9ERP	.726	.255	.282				.276		
NO8 3CSM	.721		.249			-.247			-.350
NO8 10ME	.709	.363	.302			.146	.251		.114
O5 CPLX	-.686	.102	-.226				.378		.234
NO8 5CRM	.591		-.101	.521	.187	.133	.116	.140	.118
NO8 12PT	.507			.290	.150		.354	.251	.477
NO1010CO	.213	.927	.141	.172					
NO1011CU	.260	.892							
NO10 9WE	.265	.851	.110	.254					-.150
NO10 5NE	.119	.777	.266	.402			.267		-.119
NO10 4BU	.119	.777	.266	.402			.267		-.119
NO9 10CO	.102	.772	.302			.301	-.128		.132
NO9 11CU	.111	.702		-.197		.368	-.167	.335	
NO10 6IN	.259	.612	.139	.332	.163		.371		-.123
NO10 8IM	.163	.548	.435	.159	.239	.421	.155		
NO9 9WEB	.146	.538	-.101	.189	-.154	.515			-.241
NO10 1PH		.169	.896			.117	-.199		
NO10 3EM	.409	.143	.783						
NO10 2ME	.182	.282	.673		-.256			.359	-.167
NO9 7EXT	.231	.349	.609	.129			.168		
NO10 7EX		.340	.593	.217	-.115	-.285	.387	.206	
NO9 4 BU		.368	.102	.740		.262		-.129	
O4 5 SYS	-.258	-.190		-.732		.165		-.128	.203
NO9 5NEW		.548	.227	.721	.108				
NO8 6 DW	.552		.104	.607		.148	-.107	-.264	
O4 1 BUS				.128	-.856		-.117		
O4 3 MIL	-.122	.227	-.356	.162	.643		-.195	-.376	-.242
O4 2 FIR	.108			.133	.576	.228	-.320	.187	
O4 6 OTH	.255	.135	-.409	.190	.539	-.227			-.222
NO9 8IM	.339	.183				.815			
NO9 1 PH		.153			-.100		.735	.119	
NO9 2 ME		.175		-.144	.232	-.201	.291	.737	
NO9 6INT	-.239		.280	.193		.299		.671	-.154
O4 4 SHR	.188				-.119	-.175		-.109	.802

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 16 iterations.

h. Only cases for which On Schedule (REV) = 5 are used in the analysis phase.

Total Variance Explained^a

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	14.747	33.927	33.927	8.947	21.303	21.303
2	5.163	12.292	46.214	8.063	19.197	40.501
3	3.805	9.059	55.273	4.426	10.537	51.038
4	2.155	5.131	60.404	3.178	7.566	58.604
5	2.063	4.912	65.316	2.819	6.712	65.316
6	2.004	4.773	70.088			
7	1.678	3.995	74.084			
8	1.507	3.589	77.672			
9	1.275	3.035	80.707			
10	.988	2.352	83.059			
11	.931	2.217	85.276			
12	.870	2.072	87.348			
13	.822	1.958	89.305			
14	.746	1.775	91.081			
15	.630	1.500	92.581			
16	.538	1.282	93.863			
17	.455	1.082	94.945			
18	.397	.945	95.890			
19	.335	.798	96.688			
20	.275	.654	97.343			
21	.234	.558	97.901			
22	.181	.430	98.331			
23	.169	.404	98.735			
24	.139	.330	99.064			
25	.116	.275	99.340			
26	9.502E-02	.226	99.566			
27	6.727E-02	.160	99.726			
28	5.807E-02	.138	99.864			
29	3.324E-02	7.915E-02	99.944			
30	1.953E-02	4.651E-02	99.990			
31	4.141E-03	9.858E-03	100.000			
32	1.059E-15	2.520E-15	100.000			
33	6.474E-16	1.542E-15	100.000			
34	2.524E-16	6.011E-16	100.000			
35	2.439E-16	5.807E-16	100.000			
36	1.427E-16	3.398E-16	100.000			
37	5.055E-17	1.203E-16	100.000			
38	1.239E-17	2.951E-17	100.000			
39	9.780E-17	-2.329E-16	100.000			
40	3.356E-16	-7.991E-16	100.000			
41	3.563E-16	-8.483E-16	100.000			
42	8.672E-16	-2.065E-15	100.000			

Extraction Method: Principal Component Analysis.

a. Only cases for which On Schedule (REV) = 5 are used in the analysis phase.

Rotated Component Matrix^a

	Component				
	1	2	3	4	5
NQ8_14WM	.872	.226			-.114
NQ8_7_DS	.850	.144		.105	
NQ8_13PD	.835	.365		.200	
NQ8_4CIM	.825	.341	.169		
NQ8_8EDI	.790	.270		.339	
NQ8_11OM	.768	.317	.292	-.155	.173
NQ8_10ME	.728	.395	.288	-.103	.137
NQ8_9ERP	.725	.216	.288		.191
NQ8_2APS	.721	.109	.234	-.132	-.397
NQ8_5CRM	.673	.138	-.127	.337	.172
NQ8_12PT	.664		-.185		.499
NQ8_6_DW	.616	.196	.113	.355	-.143
NQ8_1ABC	.573		.452	.185	-.196
NQ8_3CSM	.551	-.136	.546	.252	-.145
Q5_CPLX	-.540	.138	-.420	-.233	.386
Q4_4_SHR	.358	-.200	-.233	-.317	.147
NQ9_10CO		.808	.221	-.124	
NQ10_5NE	.147	.790	.245	.329	.332
NQ10_4BU	.147	.790	.245	.329	.332
NQ1010CO	.203	.784	.228	.242	.160
NQ10_8IM	.213	.761	.200		
NQ1011CU	.259	.738	.155	.195	.144
NQ10_9WE	.225	.724	.268	.340	.176
NQ9_11CU		.722		-.146	
NQ9_9WEB	.128	.718			
NQ10_6IN	.289	.638	.114	.306	.337
NQ9_5NEW	.148	.594	.158	.506	.320
NQ9_8IM	.376	.585		-.209	-.228
NQ9_4_BU	.141	.553		.358	.138
NQ10_1PH		.287	.788	-.129	-.117
NQ10_2ME		.285	.777		.244
NQ10_3EM	.376	.190	.682		
NQ9_7EXT	.203	.375	.591		.238
Q4_1_BUS			.343	-.237	-.132
NQ9_6INT	-.291	.249	.294		.191
Q4_6_OTH	.186		-.292	.679	
Q4_5_SYS	-.257	-.146	-.129	-.625	-.177
Q4_3_MIL	-.131	.193	-.438	.619	-.318
Q4_2_FIR		.207	-.198	.348	-.214
NQ10_7EX		.240	.553		.642
NQ9_2_ME	-.117				.572
NQ9_1_PH		.199		-.159	.540

Extraction Method: Principal Component Analysis.
 Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 10 iterations.

b. Only cases for which On Schedule (REV) = 5 are used in the analysis phase.