REPORT ON THE 1995/1996 SOFTWARE EXCELLENCE SURVEY

by

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Report on the

1995/1996 Software Excellence Survey

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Executive Summary

The Software Excellence Survey was conducted during the second half of 1995 by the European Software Institute (ESI), Bilbao, Spain in collaboration with INSEAD, Fontainebleau, France. A total of 85 responses were received from SPUs in different European countries. About 60% of the respondents were software divisions within a larger organizational unit, while the rest were autonomous companies.

The notion of "Software Excellence", i.e., excellence in all aspects of the creation and application of software in the general organizational context, forms the fundamental basis of the Software Excellence Survey which has been modeled after the European Quality Award. The logic of the model is that in any Software Producing Unit (SPU), Leadership driving Policy & Strategy, SPU People Management, End-user Management, Resource Management and Processes lead to Software Excellence, which in turn enhances End-user Satisfaction, SPU People Satisfaction, a positive Impact on the Organization and effective Business Results for that organization.

The average total score for Software Excellence among the surveyed SPUs is 473 out of a maximum of 1000 points. This indicates that there is need for further investment in achieving Software Excellence. Only four surveyed SPUs have scores of more than 700 and thus can claim to have achieved a measure of Software Excellence.

The surveyed SPUs are weak in aligning their goals and strategies with those of the parent business unit. There is little reported progress on making SPU employees more empowered. While the project management procedures are common, there is little use of metrics in all aspects of Software Excellence. Regular and systematic benchmarking of operating and customer data to find opportunities for continuous improvement is yet to be widely implemented. Few SPUs claim to have a realistic overview of customer complaints. While SPUs collect customer data, they have generally neither established the relevance of these measures or benchmarked them against external organizations.

There are significant differences in the adoption levels of different management practices between SPUs with high and low Software Excellence scores. High scoring SPUs demonstrate a higher level of top management involvement, emphasize the satisfaction and career development of their personnel and build more effective partnerships with end-users.

The most important competitive priorities for the surveyed SPUs are to develop reliable products, to provide effective maintenance support and to be able to make rapid design changes. Looking at the next three years, the competitive priorities are expected to shift towards providing reliable software on schedule and within budget. These shifts reflect the operational pressures faced by SPU managers.

1 Introduction

This section introduces the need for excellence in software and outlines the focus and structure of the report.

1.1 Software and its Challenges

Software forms the "back-bone" of major industries such as banking, airlines and publishing, and is an increasingly important value-adding component of consumer products such as television sets, cameras, cars and mobile phone sets. Software is today a dominant force in enabling companies to exploit new distribution channels, create new products and deliver differentiated value-added services to customers. In reality, there is often little difference between an organization's software strategy and its business strategy.

The strategic importance of software has been long understood by practitioners and researchers[1]. However, organizations have been puzzled by a couple of challenges in successfully leveraging software. For one, researchers have noted the "productivity paradox"[2] - a set of studies which have found little or no benefits to organizations from investments in information technology. This is particularly significant when the delivered computing power in many developed economies has increased by more than two orders of magnitude over the past two decades. There is growing concern that there is often a fundamental mis-alignment between the software and business strategies of many organizations[3].

In addition, stories of dramatic time and cost overruns of software projects are legendary. Gibbs[4] notes that:

> "for every six new large-scale software systems that are put into operation, two others are canceled. The average software project overshoots its schedule by half; larger projects generally do worse. And some three quarters of all large systems are "operating failures" that either do not function as intended or are not used at all." (pp. 72-73)

These software debacles are even more distressing when one notes that the amount of software code in most systems (both embedded and stand-alone) is doubling every two or three years. These size increases are accompanied by corresponding demands on increased functionality and quality.

1.2 Focus of Report

Over the last decade, several models have been proposed and used within industry for assessing and improving software development processes. The most popular of these is the Capability Maturity Model (CMM), which has been developed by the Software Engineering Institute (SEI) at Carnegie Mellon University[5]. The focus in CMM and similar models is on addressing chronic problems in software development processes. They typically address issues such as whether an organization has appropriate software project management procedures in place and whether the right metrics are being

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[1] Porter, M.E. and V.E. Millar, How information gives you competitive advantage, Harvard Business Review, pp. 149-160, July-August 1985.
[2] Brynjolfsson, E., The Productivity Paradox of Information Technology, Communications of the ACM, 35, 66-77, 1993.
[3] Dutta, S., Aligning IT and Business Strategy: The Role and Responsibility of Senior Management, European Management Journal, 1996.
[4] Gibbs, W.W., Software's Chronic Crisis, Scientific American, pp. 72-81, Sep. 1994.
[5] Paulk, M.C., The Evolution of the SEI's Capability Maturity Model for Software, Software Process-Improvement and Practice, Pilot Issue, pp. 3-15, 1995.

collected and utilized for managing software processes. Empirical evidence in the literature[6] suggests that substantial improvements can be obtained from the systematic application of software process assessment models.

Current software assessment models are largely restricted to the software development process. Given the hurdles in obtaining adequate returns from rapidly escalating software investments, and in aligning software strategy with an organization's business strategy, there is a need to include the broader organizational context of the application of software within models for assessing and improving the strategic leverage of software within firms.

Guidance can be obtained from the domain of Total Quality Management (TQM) where research over the past four decades has incrementally extended the focus of total quality models from "products" and "manufacturing" to a notion of overall business excellence. This report integrates the strengths of current software process assessment models with the overall business-wide scope of TQM models to arrive at a model of Software Excellence (SE) - which defines the degree to which an organization is succeeding in both creating the enabling conditions and also in obtaining results for developing and applying software to create value for all key stakeholders of the organization.

1.3 Structure of Report

There are six additional sections of the report. The next section describes an integrated model for assessing Software Excellence. Section 3 describes the research design used for this study. The next three sections describe the empirical results from our survey. Section 4 describes general results and overall scores of SE among the surveyed organizations. This is followed by an analysis of the key differences among organizations with high and low overall SE scores. Section 6 focuses on the competitive priorities and the degree of use of various assessment/audit techniques among the respondents. The last section summarizes the main findings of the study.

2 The Software Excellence Model

In line with the notion of "business excellence" inherent within the European Quality Model[7], we define "Software Excellence" (SE) as follows.

> *In any Software Producing Unit (SPU), Leadership driving Policy & Strategy, SPU People Management, End-user Management, Resource Management and Processes lead to Software Excellence, i.e., excellence in all aspects of the creation and application of software in the broad organizational context. Software Excellence in turn leads to End-user satisfaction, SPU People Satisfaction, a positive Impact on the Organization and effective bottom-line Business Results for the organization.*

In the above definition, we use the term SPU (Software Producing Unit) to refer to either an independent information technology organization within a larger parent company or an information technology division or department within a "user" organization.

Adapted from the European Quality Award model, the framework used for define SE is shown in Figure 1. There are ten aspects to be considered in total, which are organized

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[6] Herbsleb, J., A. Carleton, J. Rozum, J. Seigel and D. Zubrow, Benefits of CMM Based Software Process Improvement: Initial Results, Report CMU/SEI-94-TR-13, Software Engineering Institute, Pittsburgh, 1994.

[7] Lascelles, D. and R. Peacock, Self-Assessment for Business Excellence, London, Mc-Graw Hill, 1996.

into two categories: Enablers and Results. Enablers are more concerned with *how* things are done. Results are more focused on what *has* been achieved. Table 2 lists the constituent elements of Enablers and Results with some examples of the type of aspects considered for each element.

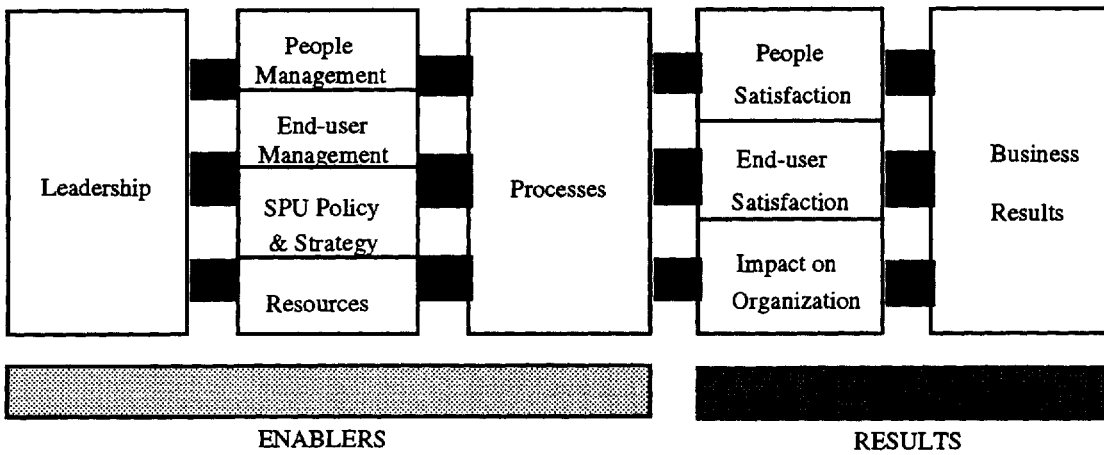

Figure 1: Software Excellence Model

There are two major changes in the SE model as compared to the European Quality Award model. One, End-user Management has been introduced as a key element of the Enablers. This is in recognition of the importance of partnerships with end-users for the success of software projects. Two, the element "Impact on Society" has been changed to "Impact on Organization" in recognition of the fact that a SPU exists within the context of the parent organization analogous to an organization existing within society at large.

A total of 1000 points has been divided equally between the Enablers and the Results (see Table 1). The proportion of points assigned to each constituent element of Enablers and Results is guided by the assignment of points for the European Quality Award.

3 Study Design

The study reported in this report is based on the results of a survey conducted of European organizations in late 1995. The research and survey described below was conducted by the European Software Institute, Bilbao, Spain in collaboration with INSEAD, Fontainebleau, France. This section describes the research design used in the study.

3.1 Design of Questionnaire

Several sources of information were used for the design of a questionnaire based on the SE model. First, the existing body of literature on Software Maturity Assessment and Quality Models was scrutinized carefully. In particular, questions used to assess business excellence within the European Quality Award model and software maturity models were found to be particularly useful for the design of the questionnaire. Second, several discussions were conducted with managers to elicit the key aspects of software excellence as perceived by practitioners. Finally, the resulting questionnaire was pre-tested with selected INSEAD MBA participants and evaluated by experts both at INSEAD and ESI for clarity and relevance of the individual questions.

The SE questionnaire was made up of four sections. Appendix A provides more details on the structure of the questionnaire and the nature of the questions contained within it.

Category/Dimension (Points assigned)	Examples of Aspects Considered
Enablers (500)	
Leadership (90)	The role of senior managers in creating and driving a culture of software excellence throughout the organization.
SPU Policy and Strategy (60)	The role of software excellence in the organization's values, vision, strategic direction and the implementation of its policy and strategy.
SPU People Management (70)	How the organization manages the SPU employees and releases their potential to continuously improve the business.
End-user Management (90)	The nature of partnerships created with the customers of the SPU.
Resource Management (70)	The management, utilization and preservation of financial and non-financial resources by the SPU in a planned manner.
Software Processes (120)	The identification, management and continuous improvement of all key processes related to the development of software.
Results (500)	
SPU People Satisfaction (90)	The organization's success in meeting the needs and expectations of its SPU employees.
End-user Satisfaction (200)	The organization's success in satisfying the needs and expectations of its customers (both internal and external).
Impact on Organization (60)	The success of the SPU in satisfying the needs and expectations of the organization at large.
Business Results (150)	The success of the SPU in making the appropriate contribution to the financial success and other business targets of the organization.

Table 1: Key Aspects of Constituent Dimensions of Enablers and Results

3.2 Data Collection

The SE questionnaire was sent to around 3,000 companies all over Europe. The data sample was distributed over all the European countries with at least 200 companies from each of the top 10 countries in order of GDP, and at least 100 companies each for the rest of the countries. Companies were selected from a number of industrial sectors including information technology, manufacturing, business and services.

A total of 85 duly completed questionnaires were received from companies (see Appendix B for a profile of the respondents). This represents a response rate of 2.84%. The low response rate can be attributed to the length of the questionnaire (20 pages), the timing of the mailing (during the summer month of August '95) and a lack of follow-up with telephone or other direct contact after the mailing.

3.3 Analysis Outline

The reliability of the multi-item scale used in the SE questionnaire was measured with the inter-item correlation matrix. Cronbach's alphas for each category of Enablers and Results in the SE model was seen to be higher than 0.9. This suggests that the scales used to measure the various categories of Enablers and Results are reliable.

Due to a lack of a sufficient number of responses from individual countries, it was decided to undertake an aggregate analysis rather than a country analysis.

The research results presented below consists of three parts. The focus in the first part (Section 4) is on determining overall scores of Software Excellence for all responding organizations. In the next part (Section 5), we divide the responding companies into two categories - companies with high overall SE scores and those with low overall SE scores - and analyze the key differences between these two groups. The last part (Section 6) is concerned with an analysis of the competitive priorities of the responding companies and their level of use of different assessment/audit techniques.

4 General Results

This section describes the overall scores of SE determined in the survey and also presents an analysis of the scores for the Enabler and Result categories for all respondents.

4.1 Scores of Overall Software Excellence

An overall score of SE was computed for each SPU out of a maximum of 1000 points in the following manner. Note that Appendix A describes the five point response scale used for all questions related to the Enabler and Result categories. The marked responses for all questions within a particular category were first aggregated and normalized. The final score for a SPU was calculated by weighting the normalized scores for each Enabler and Result category of the SPU by the differential weights shown in Table 1 and then aggregating them into an overall score of SE.

The average SE score across all respondents is 473 out of a maximum of 1000 points (with a standard deviation of 125). The average scores for the Enablers and Results for all respondents are 256 and 217 respectively out of a maximum of 500 points each (with standard deviations of 62 and 70 respectively).

It is preliminary to establish the appropriate threshold for truly world-class SE in companies. However some guidance can be obtained from the profiles of scores achieved by companies winning major Quality Awards. Allowing for variations in assessor ratings and in the underlying model, Lascelles and Peacock[8] note that "...anything between 700 and 800 points represents genuine world class. Anything above 600 points represents a level of excellence to which few companies can aspire. A typical score for an organization that is being run competently and has a set of good results is 450 points" (p. 77).

The distribution of the overall SE scores is depicted in Figure 2. Focusing on the current SE scores, none of the responding companies score above 800 and thus can be said to have achieved truly world-class SE[9]. Five companies have obtained scores in

[8] Lascelles, D. and R. Peacock, Self-Assessment for Business Excellence, London, Mc-Graw Hill, 1996.

[9] It should be noted that the methodology (such as the five point scale for questions in the SE survey) used to calculate the SE score is not the same as that used to compute the business excellence score in the European Quality Award. Thus it is strictly not possible to directly compare the SE and Quality Award scores.

the range of 700 - 799 and can claim to have achieved a measure of SE. About 50% of all respondents score below 500 and this gives an indication of the degree to which they can further improve their respective levels of SE.

The "future" SE scores of Figure 2 are computed on the basis of the importance assigned by the responding SPUs to each dimension of the SE model over the next three years (also see Table 4). Thus they cannot be directly compared to the current SE scores. However, a distinct shift towards a "higher score" can be observed by comparing the current and future "scores" in Figure 2. The average for the future score is 657 with a standard deviation of 106. The average future scores for the Enablers and Results for all respondents are 350 and 307 respectively out of a maximum of 500 points each (with standard deviations of 48 and 68 respectively). Clearly, all responding SPUs wish to improve their overall levels of SE in the near future with a stronger emphasis on the Enablers.

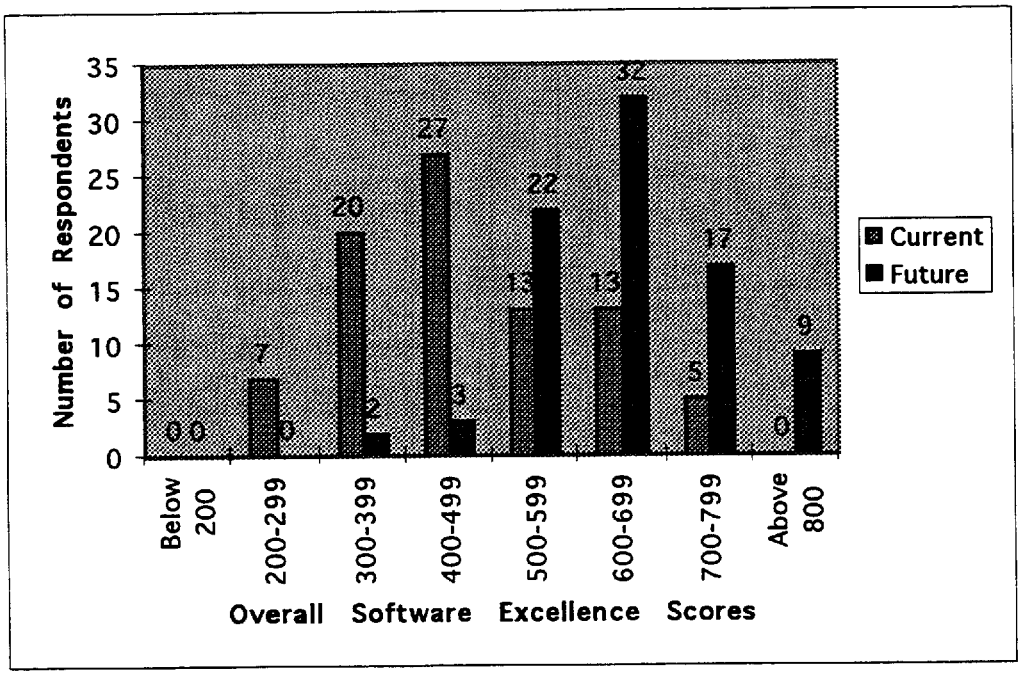

Figure 2: Distribution of Overall Software Excellence Scores (Current and Future)

Most organizations score below 500 in assessments using the European Quality Award model. It is also a fact that software process maturity assessments have demonstrated fairly low levels of software process capability in most organizations. Gibbs[10] notes that as of 1994, of all the 261 organizations world-wide assessed using the CMM model, a staggering 75% were at level 1 - the Initial level with no formal processes, no measurements and no way to track their progress/failure; only two organizations world-wide were found to be at the highest (Optimized) level of the CMM model.

Against this background, the overall SE Scores seem a bit optimistic - about 36% of the respondents score above 500.This could be due to a genuine upward bias in the responses due to the limitations of self-assessment by the questionnaire format of the current survey. The European Quality Award and CMM/Bootstrap assessments use a more rigorous approach comprising several field visits and in-depth interviews by trained external assessors - aspects which are difficult to replicate in the current SE survey.

[10] Gibbs, W.W., Software's Chronic Crisis, Scientific American, pp. 72-81, Sep. 1994.

4.2 Analysis of Enablers and Results

Normalizing each dimension of the SE model to a scale of 100, the average scores (both current and future) for each category of Enablers and Results are shown in Figures 3 and 4 respectively. Focusing first on the current scores, it can be observed that the responding SPUs are weaker on the Result dimensions as compared to those of the Enablers. An analysis of the individual questions for the Enabler and Result dimensions leads to the following findings for the responding SPUs. Note that the quantitative numbers mentioned below within brackets following particular statements are the average scores on a scale of 1 to 5 (see Table A1 of Appendix A) for all respondents for the respective statement in the SE survey.

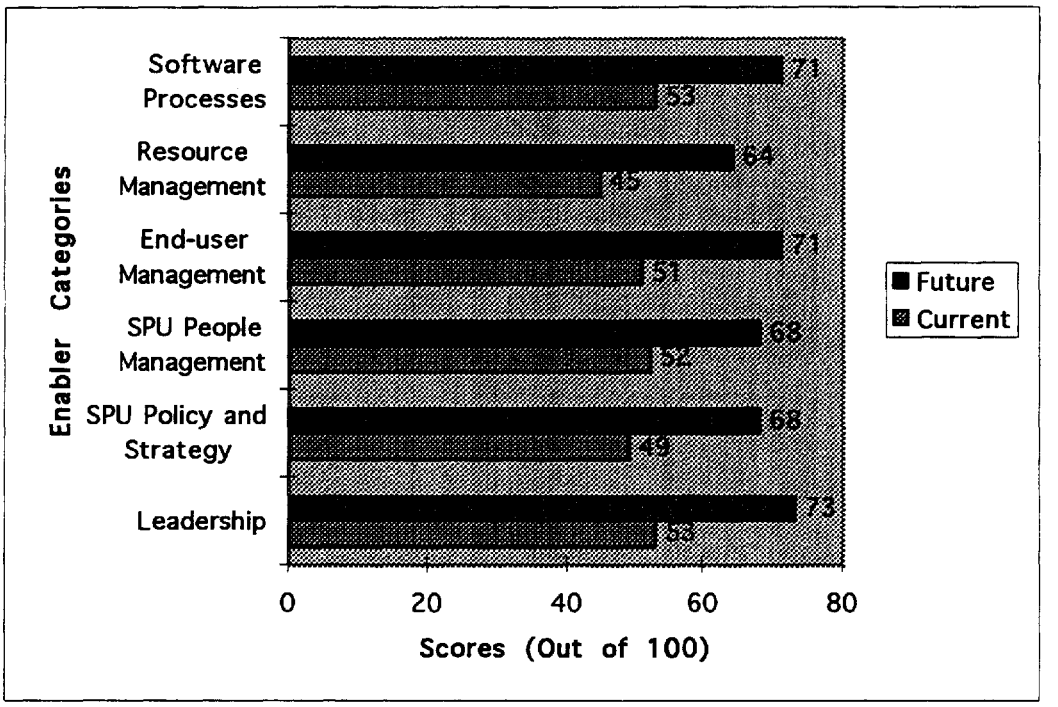

Figure 3: Average Scores each Category of Enablers

In only about half the responding SPUs, the strategy and mission of the SPU is set personally by senior management (2.75). A large number of SPUs said that progress towards achieving software excellence is retarded by the fact that senior management display a lack of commitment and do not "walk the talk" with appropriate follow-up actions (2.5). Few respondents felt that there is a method for evaluating whether the SPU goals are attainable and if they fit the strategy of the parent business unit (2.2).

The overall findings of the SE survey are consistent with these observations from the literature which has documented the lack of adequate involvement of senior management in the planning and execution of technology strategy. Business managers frequently do not consider technology to be an area in which they needed to get involved personally. Jarvenpaa and Ives[11] mention that "few nostrums have been prescribed so religiously and ignored as regularly as executive support in the development and implementation of management information systems" (p. 205).

The importance and utility of having end-users participate in the software development process for defining the requirements and specifications is well documented in the

[11] Jarvenpaa, S.L. and Ives, B., Executive Involvement and Participation in the Management of Information Technology, MIS Quarterly (15:), pp. 05- 7, June 1991.

literature[12]. Thus, it is not surprising to find that on average, the responding SPUs have created procedures to create partnerships with end-users in order to learn about their needs and concerns (2.95). However these partnerships are, in general, not created either on a continual basis or at all levels of SPU personnel (2.63). Procedures for obtaining regular feedback from end-users (2.53) and for reviewing the scope and coverage of the relationships with them are weak (2.3). As a result, SPUs do not have a realistic overview of all customer complaints (2.55). While SPUs collect customer data, they have neither established the relevance of these measures for customer satisfaction (1.93) nor benchmarked them against comparable external organizations (1.79). Thus the concept of a true partnership which extends beyond the software development process and evolves over time for the mutual benefit of both the SPU and its end-users is not well developed in the responding SPUs.

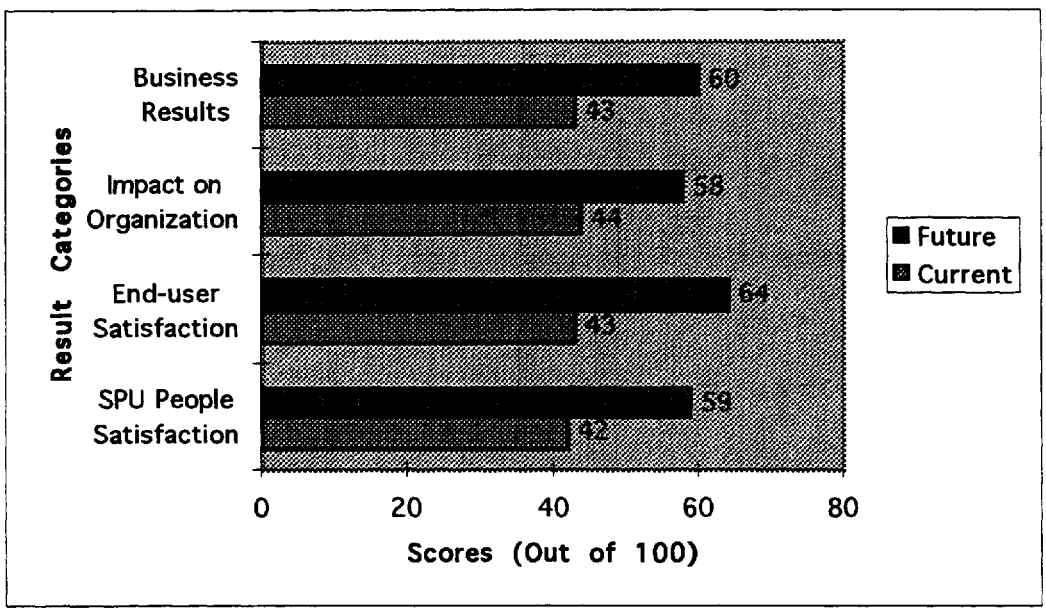

Figure 4: Average Scores each Category of Results

The effective management and satisfaction of personnel is an area of general weakness for the responding SPUs. There is little progress in making SPU personnel more empowered to act and take responsibility without increasing business risk (2.23). Most SPUs do not regularly measure factors (such as staff turnover) which influence or predict their personnel satisfaction (2.16). The career development plans for SPU personnel are not adequately linked to the business plans of the SPU (2.55) and the recognition and reward of their efforts are performed informally (2.32). Few SPUs have succeeded in involving their employees in generating ideas for continuous improvement, either individually or in groups (2.68). It is also interesting to note that in most SPUs, management does not publicize results of SPU personnel perceptions and act on them accordingly (1.93).

The above findings are supported by the literature. While the concepts of empowerment and career development have been researched extensively by organizational researchers, Igbaria notes that[13] "little attention has been devoted to exploring job involvement and its relationship to the work experiences and job attitudes of IS personnel" (pp. 176-177). These observations are important because SPU personnel have evolved over the

[12] Ives, B. and M.H. Olson, User Involvement and MIS Success: A Review of Research, Management Science, Vol. 30, No. 5, pp. 586-603, May 1984.
[13] Igbaria, M., S. Parasuraman and M.K. Badawy, Work Experiences, Job Involvement, and Quality of Work Life Among Information Systems Personnel, MIS Quarterly, pp. 175- 01, June 1994.

years as a large and distinct group of organizational employees who through the implementation of new technologies directly and indirectly impact the consciousness and practices of other organizational employees. Without their commitment, it is unlikely that an organization can leverage technology successfully.

Relative to the other categories of Enablers, the responding SPUs score higher along the Processes dimension. This reflects the investment that many SPUs have made in improving their software processes.. While project management procedures are commonly adopted in most surveyed SPUs (3.03), few report having systematic processes to evaluate and manage project related risks (2.5). The use of metrics for managing software processes is poor (2.27). The responding SPUs emphasize the structuring of the processes to code and test software (2.96) and the creation of a detailed software design is a routine part of the development process (3.04). However, there is little emphasis on the systematic reuse of software components (1.98).

Regular and systematic benchmarking of customer data to find opportunities for continuous improvement is yet to be widely implemented (1.79). While many SPUs report to be formally measured by the parent business unit, few explain these measures and their links to SPU performance to their own personnel (2.16). The impact of the SPU on the parent business unit is rarely compared against external benchmarks and most SPUs do not have an idea of their performance relative to their competitors (1.91).

Analogous to the current SE scores, the future scores for each Enabler and Result category in Figures 3 and 4 are computed on the basis of the assigned importance to each item constituting the scale for the respective category. Comparing the current and future "scores" it can be observed that the responding SPUs assign a higher level of importance to all dimensions of Enablers and Results. More importance is given in general to the Enablers as compared to the Results categories. Also, all scores are clustered within relatively narrow ranges. This indicates a possible lack of discriminatory focus in investments for enhancing SE - SPUs may not be necessarily be obtaining the right balance in their efforts along different categories of Enablers and Results.

5.5 Analysis of Variance

An analysis was performed to understand the proportion of variance in the Result categories explained by the Enabler categories. This is important because the SE model posits a direct positive effect of the Enabler categories on the Result categories.

Table 2 summarizes the variance explained in each Result category by the best two category model (i.e., the model containing two Enabler categories which explains the largest amount of variance among all such models for the corresponding Result category) and a model comprising all Enabler categories. The results are very encouraging as a large amount of variance (ranging from a low of 41.5% for End-user Satisfaction to a high of 64.3% for Impact on Organization) in the Result categories can be explained by the Enabler categories. This is despite the large inherent diversity in the respondent sample (see Appendix B). The results in Table 2 provide broad support for the SE model - an investment in the Enablers is associated with an increased return to all key organizational stakeholders.

5 What Distinguishes the High Scorers from the Low Scorers?

As a second phase of the analysis, two subsets were selected from the responding companies - twenty companies with the highest and lowest overall SE scores - henceforth termed as the High Scorers and Low Scorers. This section outlines the key differences between these two subsets.

Result Category	Enabler Category(ies)	Proportion of Variance Explained
Best Models with two Enabler Categories (All Respondents)		
SPU People Satisfaction	SPU People Management Processes	47.45%
End-user Satisfaction	End-user Management Processes	42.51%
Impact on Organization	SPU Policy and Strategy SPU People Management	63.67%
Business Results	End-user Management Processes	46.84%
Models Considering all Enabler Categories (All Respondents)		
SPU People Satisfaction	All Enablers	46.2%
End-user Satisfaction	All Enablers	41.5%
Impact on Organization	All Enablers	64.3%
Business Results	All Enablers	47.3%

Note: $p \leq 0.01$ for all numbers

Table 2: Variance Explained in Result Categories by Combinations of Enablers

	All Respondents		High Scorers		Low Scorers	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Current Scores						
Overall SE Score (1000)	473	125	653	56	321	35
Enablers (500)	256	62	335	37	181	24
Results (500)	217	70	317	34	139	23
Future Scores						
Overall SE Score (1000)	657	106	741	67	589	106
Enablers (500)	350	48	381	43	322	50
Results (500)	307	68	359	36	266	65

Table 3: Software Excellence Scores Summary

5.1 Summary of Overall Differences

Table 3 compares the average future and current scores for the High and Low Scorers with all responding SPUs. The Mann-Whitney U Test[14] was used to confirm that there is a statistically significant difference ($p \leq 0.001$) in the overall SE scores between the High and Low Scoring groups.

Figure 5 depicts the scores for the different categories of Results for the High and Low Scorers. A large difference can be observed between the two groups along all of the Result categories. This indicates that the High Scorers have been more successful in translating their investments in the Enablers to financial and non-financial business results.

Multiple discriminant function analysis was used to find the discriminatory power of each Result category for distinguishing between the High and Low Scorers. We observed that the category End-user Satisfaction has the maximum discriminatory power between the two groups (with a statistical significance of $p = 0.0004$). Thus if end-users of a SPU have a high degree of satisfaction, then it is likely that the SPU is a High Scorer. It is also interesting to note that the categories Business Results and Impact on Organization have the next highest discriminatory power among High and Low Scorers. This emphasizes the importance of including bottom-line business results in the SE model.

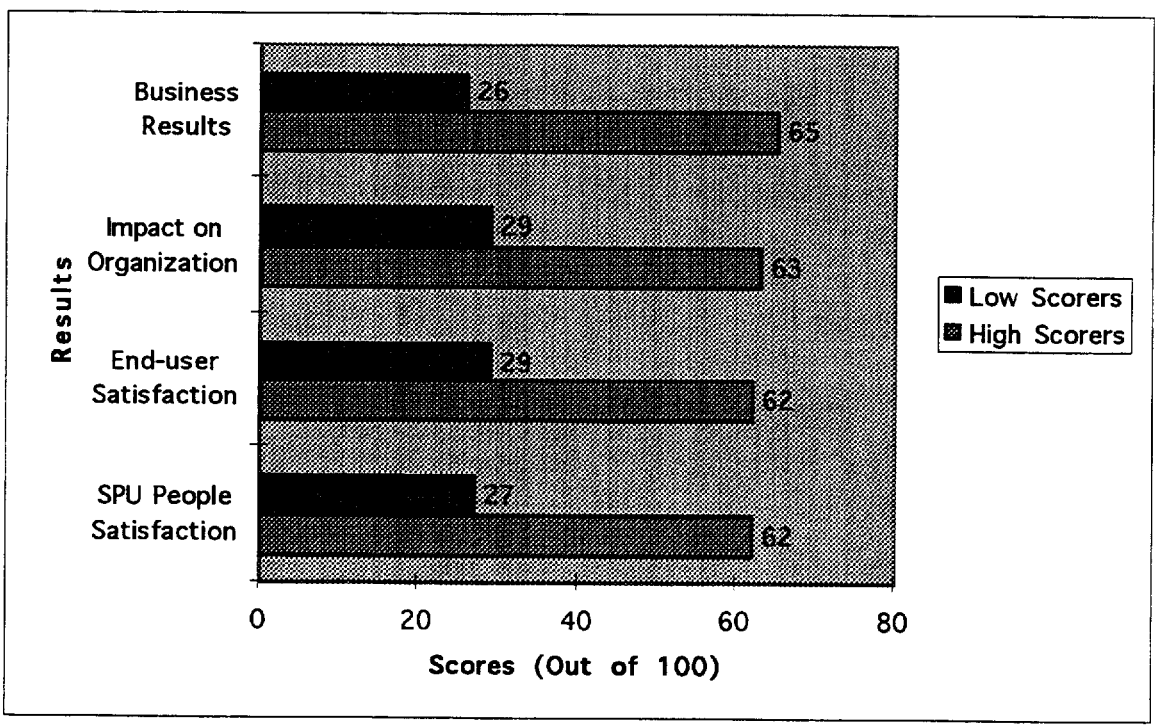

Figure 5: Current Scores of Result Categories for High and Low Scorers

Figure 6 depicts the scores for the different categories of Enablers for the High and Low Scorers. A large difference can be observed between the two groups along all of the Enabler categories.

Multiple discriminant function analysis was also used to find the discriminatory power of each Enabler category for distinguishing between the High and Low Scorers. We noted that categories SPU People Management and End-user Management have the

[14] The Mann-Whitney U test is the most powerful non-parametric alternative to the t-test for independent samples and is well suited to the sample sizes considered in our data set.

largest and highly statistically significant ($p = 0.000$) power to discriminate between the High and Low Scorers. The categories of Leadership and SPU Policy and Strategy have the next highest discriminatory power between the two groups (with a statistical significance of $p = 0.05$ levels). It is interesting to note that the categories of Resource Management and Processes do not discriminate between the High and Low Scorers.

5.2 Differences in Key Management Practices

The following paragraphs describe the salient differences in key management practices comprising the different Enabler and Result categories. The quantitative numbers mentioned below within brackets following particular statements are in the following format (HS;AR;LS) where HS, AR and LS are the average scores on a scale of 1 to 5 (see Table A1 of Appendix A) for the High Scorers, All Respondents and Low Scorers respectively for the corresponding practices in the SE survey. Table 4 provides a qualitative summary of the management practices in which the High Scorers fare significantly better than the Low Scorers.

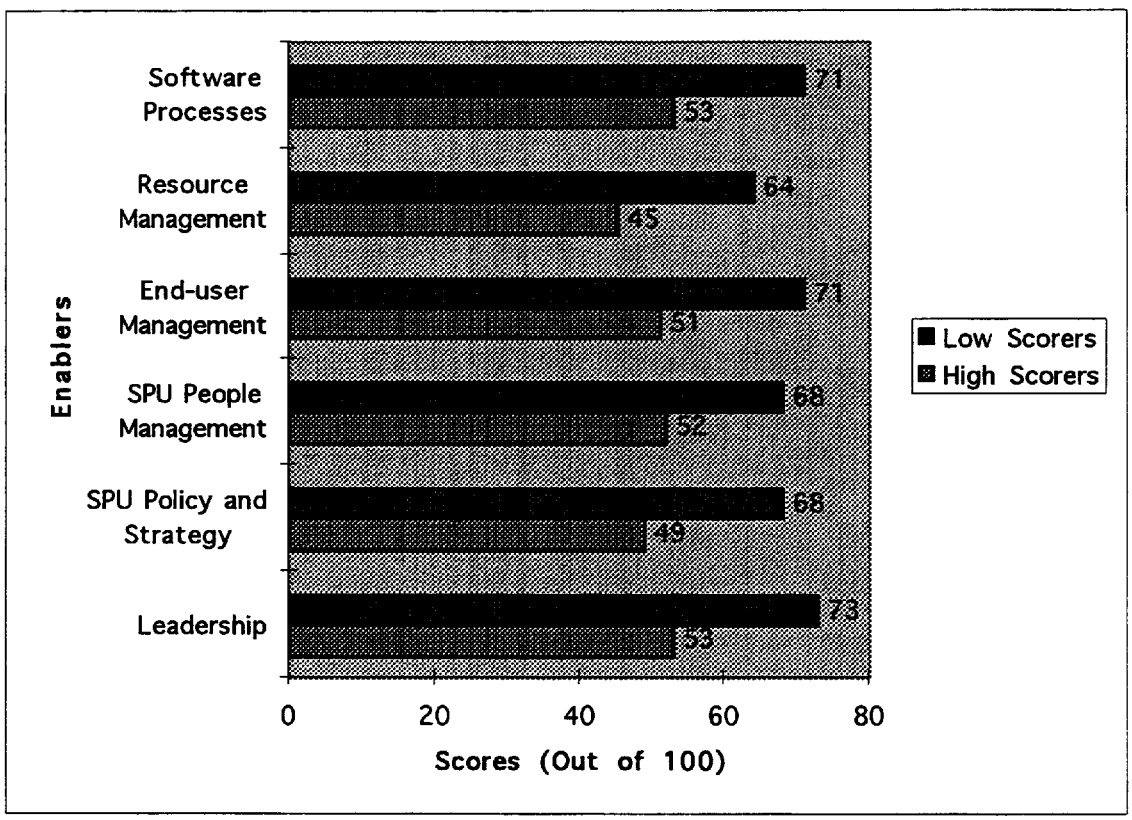

Figure 6: Current Scores of Enabler Categories for High and Low Scorers

With respect to End-user Management, a key difference lies in the creation of effective partnerships between the SPUs and their end-users (3.9;2.9;2.3). In high-scoring SPUs, personnel from all levels and functions are actively involved in partnerships with end-users (3.4;2.6;2.0). This helps to create multiple links between the SPU and its user community. In addition, partnerships with end-users are more effective in the High Scorers due to the existence of formal processes for obtaining regular feedback from end-users (3.5;2.5;1.7) and for systematic reviews and updates of the scope and coverage of the partnerships (3.2;2.3;1.5). High scoring SPUs have identified to a higher degree key customer requirements and have set service and standard levels accordingly (2.9;2.3;1.7). They have a better overview of all customer complaints and are more in tune with the needs of their customers (3.2;2.5;1.8). Cumulatively, these practices lead to a higher degree of end-user satisfaction.

While the High Scorers score much higher than the Low Scorers along the above dimensions, all of their scores for end-user management related practices are less than 4. This indicates that there is yet significant room for improvement in creating effective partnerships with end-users. However, the SE survey shows that the High Scorers are striving towards such a partnership. High scoring SPUs tend to be more integrated with the parent business unit and attempt to use technology to enhance the parent unit's performance (3.4;2.4;1.8). While more could be done by the high-scoring SPUs to promote innovation in the parent unit (3.0;2.2;1.6), they tend to have formal processes by which the SPU's goals and strategies are aligned with those of the parent unit (3.5;2.5;1.7).

Enablers	**Management Practices**
Leadership	• Intimate involvement of senior managers with the strategy, mission and progress of the SPU; and • Timely and adequate appreciation of individual and teams efforts.
SPU Policy & Strategy	• Alignment of SPU strategy with that of parent business unit.
SPU People Management	• Empowerment of employees and a dedicated focus on employee development and recognition.
End-user Management	• Active involvement of personnel at all levels and functions in effective partnerships with end-users.
Processes	• A systematic focus on identifying critical SPU processes and on explicitly managing them with appropriate metrics; and • Systematic focus on root-cause problem solution.
Results	
SPU People Satisfaction	• An open and transparent organization in which feedback from employees is encouraged and publicized.
End-user Satisfaction	• Setting of service and standard levels in accordance with key customer requirements.
Impact on Organization	• Creation of synergies of operation with the parent business unit.
Business Results	• A focus on measuring performance, comparing it with external benchmarks and disseminating them in a transparent fashion throughout the SPU organization.

Table 4: Salient Management Practices of High Scoring SPUs

A large gap is also observed between the High and Low scorers for management practices related to SPU people management. A major difference is in the degree of empowerment of SPU personnel. High scoring SPUs emphasize the empowerment of their personnel (3.0;2.2;1.6) and involve them both individually and within groups in generating improvements (3.3;2.6;2). They tend to have a more open organization in which management seeks out the perceptions of SPU personnel (3.4;2.6;1.9). However, management is not very effective in publicizing the perceptions of SPU employees and acting upon them accordingly (2.6;1.9;1.3). While the high scoring SPUs derive their people plans directly and formally from their business plans (3.2;2.5;1.9) they can improve their processes for reviewing employee development and recognizing and rewarding their efforts (2.9;2.3;1.7). Progress also needs to be made in achieving an effective two way communication between management and SPU

personnel (3.1;2.7;2.2) and making SPU personnel feel that their opinions are valued (3;2.7;2.2).

Even among the High Scorers, the average scores for aspects related to SPU People Management are low (none of the scores are above 3.5). This shows that more progress is needed on this front, specially in integrating the external indicators of career success (such as salary and hierarchical position) with a recognition of the quality of work life, i.e., the degree to which employees are able to satisfy their important personal needs for growth and fulfillment[15]. Indeed, Igbaria et. al.[16] have "identified effective human resource management as a critical issue facing the IS field and have called attention to the need for improving human resource planning, recruitment, and development of IS employees" (p. 175).

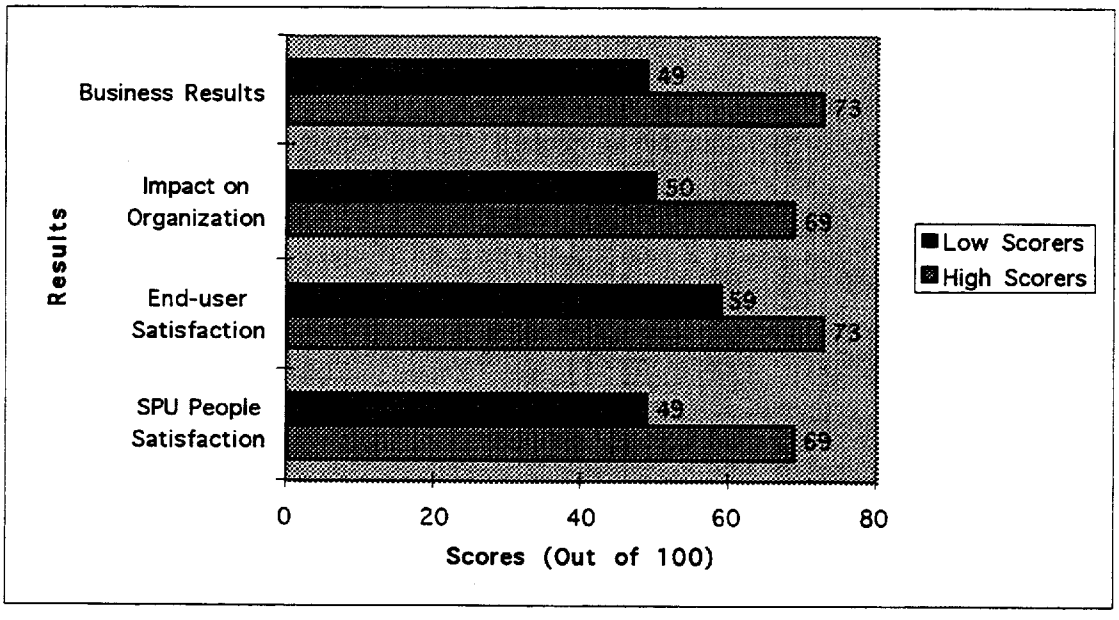

Figure 7: Future Scores of Result Categories for High and Low Scorers

A difference can also be observed between the High and Low scorers in the more intimate involvement of the senior management in setting the basic strategy and mission of the SPU (3.3;2.7;2.1). Within the high scoring SPUs, senior management take more active steps to instill a culture of SE within the SPU and the parent business unit (3.2;2.7;2.2), and show their own commitment to it by their actions (3.1;2.5;1.9). They review the SPU's progress regularly (3.3;2.6;1.8) and are more willing to appreciate the efforts of the teams and individuals contributing towards the SPU's performance (3.4;2.7;2.1). As a result, their values are widely accepted within the SPU. While senior management is more involved in the High Scorers, there is room for improvement - they do not score higher than 3.5 for any leadership-related practice.

Certain other management practices also differentiate the High Scorers, specially with respect to the use of formal measures and metrics. High scoring SPUs are more likely to have their performance measured by both financial and non-financial performance indicators (3.4;2.5;1.9) and have these measures formally reviewed periodically for relevance (3.1;2.2;1.5). They tend to have processes to evaluate the impact of the SPU's performance on the parent business unit (3.1;2.2;1.4). However, they could

[15] Suttle, J.L., "Improving Life at Work - Problems and Prospects", in Improving Life at Work: Behavioral Science Approaches to Organizational Change, J.R. Hackman and J.L. Suttle (Eds.), pp. 1-9, Goodyear, Santa Barbara, CA, 1977.

[16] Igbaria, M., S. Parasuraman and M.K. Badawy, Work Experiences, Job Involvement, and Quality of Work Life Among Information Systems Personnel, MIS Quarterly, pp. 175- 01, June 1994.

improve in their efforts to compare their results against external benchmarks (2.9;1.9;1.2) and in have these results disseminated throughout the SPU organization in a transparent manner (2.7;2.1;1.3). High scoring SPUs are better in identifying the processes critical to SPU performance and in establishing indicators for these processes (3.1;2.5;1.7). They also tend to systematically determine the root-causes of problems as opposed to generating "quick-fix" solutions (3.1;2.6;2.1).

The High and Low Scorers are reasonably similar with respect to coding, unit testing and software integration practices. However, High Scorers are better at institutionalizing formal processes by which customer requirements are converted into software requirements and a software architecture (3.5;2.9;2.3). Project management practices are equally emphasized in both high and low scoring SPUs except with respect to risk assessment and the use of metrics. High Scorers have established processes by which project risks are evaluated and take steps to manage these risks continuously (3.0;2.5;1.9); they also collect and analyze a more extensive set of software-related metrics to improve project performance (3;2.2;1.7).

Both the high and low scoring SPUs are relatively weak in management practices related to the effective management of their resources. There is a general need to have more effective processes for the allocation of financial and non-financial resources (2.8;2.2;1.6) and for ensuring the availability of reliable information for effective decision making (2.9;2.2;1.8).

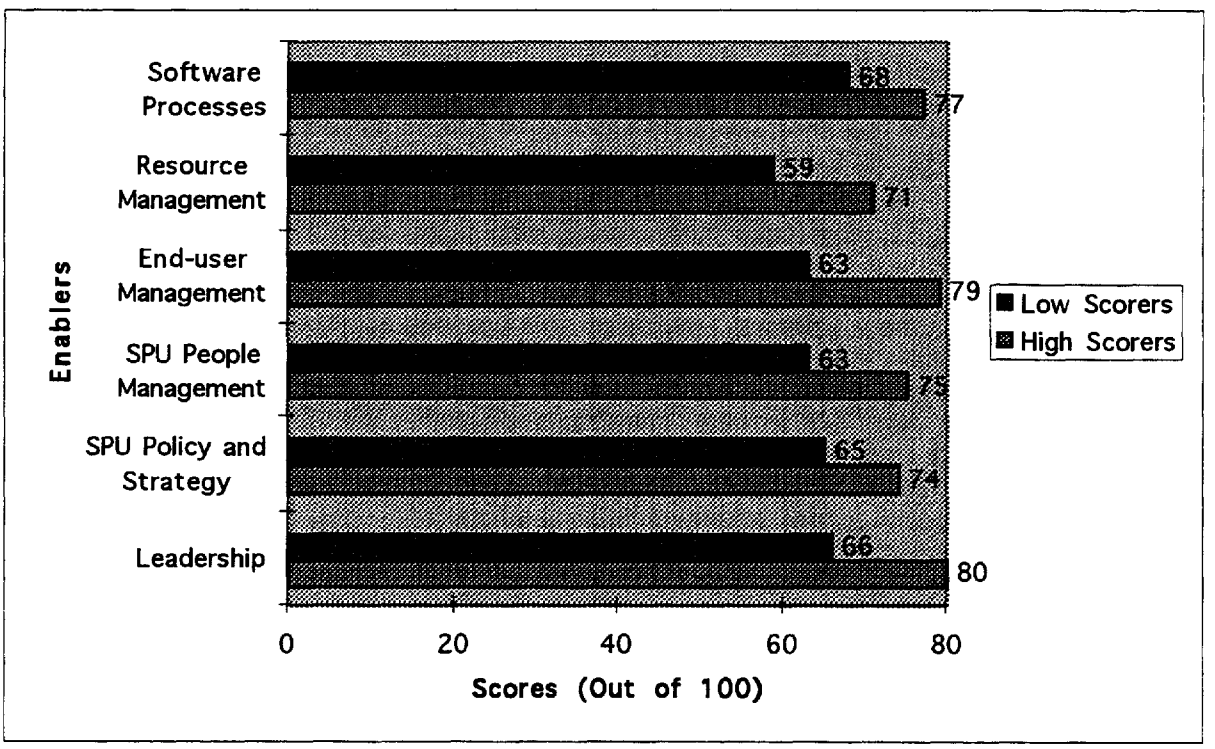

Figure 8: Future Scores of Enabler Categories for High and Low Scorers

5.3 Differences in the Future

Figures 7 and 8 outline the importance of the different categories of the Enablers and Results for the future (next three years). Once again the High Scorers assign (on average) a higher degree of importance to all categories of the SE model as compared to the Low Scorers. This indicates a higher degree of ambition among the High Scorers. However, the differences between the two groups for all categories are not statistically significant (with the Mann-Whitney U test).

An analysis of the individual management practices surveyed reveals no major changes in the pattern of emphases of key management practices among High Scorers. While the High Scorers continue to emphasize all management practices more than the Low Scorers, the gaps are in general lower than those for the current scores.

High scoring SPUs assign a higher importance to evaluating whether their goals are attainable and their degree of fit with the strategy of the parent business unit (3.7;3.4;3.1). These goals in turn are seen to have a major impact on the allocation of their financial and non-financial resources (3.8;3.2;2.9). High scoring SPUs also assign a greater emphasis on creating an effective partnership with end-users (4.5;3.9;3.7) and to continually obtain feedback from them on the performance of the partnership (4.3;3.7;3.5). Low scoring SPUs do not attach equal value to formal measures, both financial and non-financial, of SPU performance (3.9;3.2;2.9). They seem to be less inclined to analyze performance measures against external benchmarks (3.7;2.8;2.4).

6 Competitive Priorities and Use of Assessment Techniques

This section of the report summarizes the competitive priorities of all surveyed SPUs and outlines the degree to which they use various assessment/audit techniques.

6.1 Competitive Priorities

Table 5 depicts the top ten responses for the current competitive priorities for all respondents. The most important priorities are the abilities to develop reliable products, to provide effective maintenance/support and to be able to make rapid design changes. These priorities reflect the need for higher quality software systems in a world where the pace of business and its demands on software systems are evolving rapidly.

Rank	Priority
1	**Reliable** - Ability to provide reliable products
2	**Support** - Ability to provide effective maintenance / support
3	**Design Changes** - Ability to make rapid design changes
4	**Consistent** - Ability to offer consistent quality with few defects
5	**High Perf** - Ability to provide high performance products
6	**Schedule** - Ability to deliver on schedule
7	**Budget** - Ability to deliver within budget
8	**Customize** - Ability to tailor software products to match the requirements of individual customers
9	**New Tech** - Ability to introduce leading edge technology
10	**Price** - Ability to develop software at competitive prices

Table 5: Current Competitive Priorities

Table 6 lists the future (over the next three years) competitive priorities. The provision of reliable software products remains the top priority for the future. The abilities to deliver software on schedule and within budget have moved up significantly. This reflects the operational pressures faced by SPU managers in improving the maturity of their software processes. The capability to reduce time appears for the first time in the list of top 10 priorities. This indicates the pressures faced by SPU management to align their software development cycles with rapidly shrinking business planning cycles. The ability to customize software products has dropped from the top ten priorities - this may suggest increased use of standard solutions and packages.

Rank	Priority
1	**Reliable** - Ability to provide reliable products
2	**Consistent** - Ability to offer consistent quality with few defects
3	**Schedule** - Ability to deliver on schedule
4	**Budget** - Ability to deliver within budget
5	**Support** - Ability to provide effect maintenance / support
6	**Design Changes** - Ability to make rapid design changes
7	**Price** - Ability to develop software at competitive prices
8	**Fast Dely** - Ability to provide fast deliveries
9	**High Perf** - Ability to provide high performance products
10a*	**Reduce Time** - Ability to decrease time to deliver
10b*	**New Apps** - Ability to introduce new types of applications quickly
10c*	**Dependable** - Ability to provide dependable deliveries

* 10 a,b, and c have the same scores

Table 6: Future Competitive Priorities

Table 7 summarizes the major shifts, both upwards and downwards, across the current and future priorities. The upward shifts reflect the importance of being able to deliver software systems faster, on schedule, within budget and at a competitive price. The downward shifts, on the other hand, reflect "user fatigue" with new technologies and high performance products. SPU management seem to be stating that the lack of new technologies is not hampering Software Excellence; rather the critical enabler is operational excellence as reflected in reliable systems delivered on time and within budget.

Change in Rank	Priorities with Largest Increases
+6	**Fast Dely** - Ability to provide fast deliveries
+6	**Reduce Time** - Ability to decrease time to deliver
+3	**Price** - Ability to develop software at competitive prices
+3	**Schedule** - Ability to deliver on schedule
+3	**Budget** - Ability to deliver within budget
	Priorities with Largest Decreases
-5	**High Perf** - Ability to provide high performance products
-5	**New Tech** - Ability to introduce leading edge technology
-5	**Customize** - Ability to tailor software products to match the requirements of individual customers
-3	**Capacity Change** - Ability to make rapid capacity changes
-3	**Support** - Ability to provide effective maintenance/ support
-3	**Design Changes** - Ability to make rapid design changes

Table 7: Major Shifts in Competitive Priorities

A surprising finding was that the ability to exceed customer's expectations comes among the lowest overall priorities for SPU managers. This can perhaps be explained by the fact that many SPUs have yet to satisfy basic end-user needs such as quality systems delivered on time and within budget. The decrease in the priority to be able to customize software products and make rapid design changes reflects the growing emphasis on the use of standardized packages and solutions. This latter phenomenon also partially explains the decrease in the priority of the ability to provide maintenance and support.

6.2 Assessment/Audit/Certification

Figure 9 shows the percentage of all respondents who have used a particular assessment/ audit/certification technique during the last two years and who plan to use such a technique over the next two years.

It can be observed that internal quality and process assessments are used by a large number of SPUs. The use of external process assessments by independent assessors is low. Benchmarking is also not used often by the SPUs. There is however a clear trend towards increased used of internal and external quality and process assessments/audits.

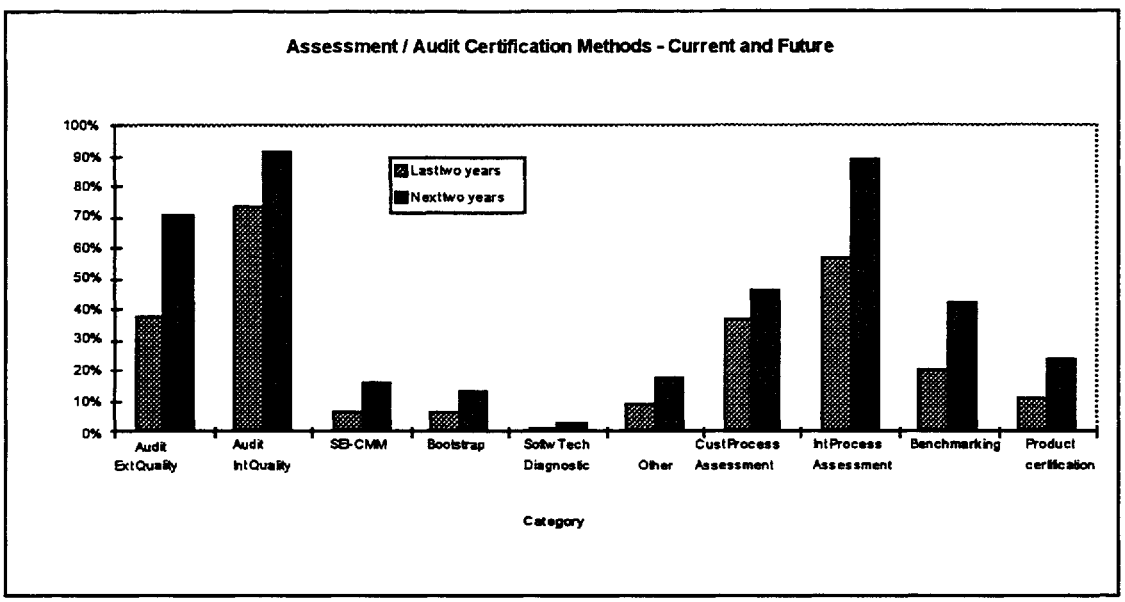

Figure 9: Assessment/audit/certification techniques used

7 Conclusion

The SE is the first survey of its kind and the obtained results are significant in many ways. First, the SE model has extended the dominant Process focus of current software maturity models such as the CMM to a broader organizational context which accounts for both investment in the Enablers (the "how to" of achieving SE) and the actual value delivered to key stakeholders of the SPU (end-users, SPU employees, shareholders and the organization at large). The survey results (see Table 2) validate the SE model and show that investment in the Enabler categories is associated positively with increased value in the Result categories.

Second, the overall scores of SE show that "Software Excellence", i.e., excellence in all aspects of the creation and application of software in the general organizational context remains a distant objective for SPUs. Despite the lack of rigorous assessment in the questionnaire format of the current survey, a large majority of the surveyed SPUs score well below 500 (see Figure 2). In particular, the scores of the Result categories are lower than for those for the Enablers. This shows that additional efforts are needed to create more value for the key stakeholders of a SPU.

Third, the SE survey has identified both strengths and limitations of the surveyed SPUs. Issues relating to senior management leadership, SPU personnel management and end-user management need more attention. Senior management need to get more involved in setting and communicating SPU strategy, and should reflect their commitment to SE by their own actions. The aspirations and careers of SPU personnel need to be managed more actively in order to increase their level of job satisfaction and

dedication to the organization. While many SPUs are taking steps to create partnerships with end-users, it is important the increase the degree of effectiveness of these partnerships.

Finally, when the SE model is used to differentiate between SPUs with high and low overall SE scores, it is clear that the high scoring SPUs score higher for all management practices than their low scoring counterparts. However, their scores for all management practices are relatively low (rarely above 3.5 and never above 4) and this highlights the large scope for further improvement in the surveyed SPUs. It is also interesting to note that aspects related to end-user management, SPU personnel satisfaction and senior management leadership discriminate between the High and Low scorers to a much higher degree than the maturity of their respective software processes.

In conclusion, while the SE model shows great promise in setting a new benchmark for assessing SE and identifying areas for improvement for SPUs, some caution is necessary in interpreting the results. The survey sample is relatively diverse - from many different countries and sectors. One should note that the results presented in this report are for the aggregate sample and thus may only be partially valid for a particular country or sector. Also, as this was the first time that the SE model was proposed and used, the management practices used to assess the different Enabler and Result categories may need to be refined further. Additional surveys in the near future should give a better feel for both the constituent elements of the SE model and the true level of SE in European organizations.

Acknowledgement

The help of Ashis Bhattacharya and Amit Pathare with the statistical analyses associated with this study is gratefully acknowledged.

Appendix A

Structure of the Software Excellence Questionnaire

The Software Excellence (SE) questionnaire was made up of a number of sections as described below:

Section A: Software Producing Unit Profile

This section had general questions about the SPU and its management, areas of operation and type of development activities undertaken. The questions covered the following areas: (a) Category of respondent; (b) Home country and Industrial sector of respondent; (c) Personnel information; (d) Development category of respondent; (e) Breakdown of software production activity; and (f) Distribution of life cycle activities.

Section B: Enablers of Software Excellence Model

This section had three blocks of questions. Question 1 had questions relating to each of the six dimensions of the Enablers of the Software Excellence model: (a) Leadership; (b) SPU Policy and Strategy; (c) SPU People Management; (d) End-user Management; (e) Resource Management; and (f) Software Processes. As the questionnaire represented a first exploratory attempt to test our model of SE within organizations, we did not have pre-tested constructs representing the constituent categories of the SE model. The use of a single item scale was discarded in favor of a multi-item scale due to the superiority of multi-item scales in respect of reliability, uni-dimensionality and freedom from specific wording bias. A Likert scale was used with multiple statements for each category, each statement covering a particular facet of the respective dimension. Table A1 illustrates the nature of questions in the SE questionnaire with the list of questions used for the Enabler category "SPU People Management".

Question 2 contained a number of means by which the performance of the SPU may be assessed, audited or certified. The respondent was asked which of these methods had been used in the past two years and which were planned to be used in the next two years. The possible responses were yes or no.

In Question 3, the priorities in the competitive capabilities of the SPU were to be specified by the respondent. The competitive priorities were grouped into five categories: (a) Price; (b) Flexibility; (c) Quality; (d) Delivery; and (e) Service. Similar to the previous question, the respondent was asked to rate the current competitive priority for the SPU and the importance of the priority over the next three years.

Section C: Results of Software Excellence Model

This Section had four questions. In Question 1, the Results of the Software Excellence model were investigated along the following dimensions: (a) SPU People Satisfaction; (b) End-User Satisfaction; (c) Impact on Organization; and (d) Business Results. For each of the above areas, the respondent was asked to rank its current practice level and its future importance within the SPU. The responses were required to be made on the 5 point scale described earlier in Table A1.

In Question 2, the respondent was asked to estimate improvements in the SPU related to the following five areas: (a) Software Development Process; (b) Sub-contracting Process; (c) Delivery Perceptions; (d) New Software Development Process; and (e) Overall Software Producing Unit Performance.

In Question 3, the respondent was asked to estimate an approximate development cost structure for the SPU.

Instructions (common for all questions of the Enablers categories)

In the following list we identify a number of factors which are enablers of the Software Excellence Strategy of the SPU. On the left-hand side, please indicate the number that best indicates the current practice levels of your SPU. The numbers representing the capability levels should be interpreted in the following manner:

1 - Absent: not performed; perhaps some good ideas but not much progress on implementation.
2 - Performed Informally: not rigorously performed; performance depending on the skill and effort of individuals
3 - Institutionalized: performance according to well-defined procedures is formalized across the organization;
4 - Controlled and Managed: subject is well understood; performance measures are systematically collected and analyzed; performance is objectively managed for improvements.
5 - Optimized: an outstanding result that is universally implemented and serves as a role model achievement.

On the right hand side, please indicate the number that best indicates the importance of each item to your SPU over the next three years. On a scale from 1 to 5, 1 represents the lowest degree of importance and 5 the highest degree.

SPU People Satisfaction

1	2	3	4	5	Does the SPU derive its people plans directly and formally from its business plans?	1	2	3	4	5
1	2	3	4	5	Is there an established and generally accepted process in the SPU for periodic employee appraisals including career development and training?	1	2	3	4	5
1	2	3	4	5	Are all SPU personnel both as individuals and groups involved in generating improvements?	1	2	3	4	5
1	2	3	4	5	Can the SPU show that SPU personnel are becoming more empowered to act and take responsibility without increasing business risk?	1	2	3	4	5
1	2	3	4	5	Does the SPU recognize and reward effort towards software excellence at the same level as other factors like qualifications or service?	1	2	3	4	5
1	2	3	4	5	Has the SPU management achieved effective two-way communication with the SPU personnel?	1	2	3	4	5
1	2	3	4	5	Do the SPU personnel feel that they are informed about activities in the SPU and do they feel that their opinions are valued?	1	2	3	4	5

Table A1: Sample questions from the Software Excellence Questionnaire

In Question 4, the financial results of the SPU were requested. These results included gross numbers like revenues, profits, etc. as well as key financial ratios.

Section D: Global Operations

In this section, the breakup of business of the SPU across the SPU's home country, Europe, North America, Asia/Pacific and the rest of the world was asked for. The linkages between the different production facilities as well as the reasons for establishing these units were also investigated. These questions were intended to give an idea of the main factors which have prompted SPUs to set up production facilities in other countries. Information was also gathered on the strategy being used for managing product development in more than one country and the major obstacles in global software operations.

Appendix B

Profile of Software Producing Units Responding to the Software Excellence Survey

The Software Excellence questionnaire was sent to around 3,000 companies all over Europe. Companies were chosen at random from the INSEAD Companies database as well as from the ESI Contacts database. The data sample was distributed over all the European countries with at least 200 companies from each of the top 10 countries in order of GDP, and at least 100 companies each for the rest of the countries. Companies were selected from a number of industrial sectors including information technology, manufacturing, business and services.

A total of 85 questionnaires were received from companies. This represents a response rate of 2.84%. The low response rate can be attributed to the length of the questionnaire, the timing of the mailing (during the summer month of August '95) and a lack of follow-up with telephone or other direct contact after the mailing.

The questionnaire data was codified and sanitized to remove invalid or incomplete responses before analysis. There were a few missing data for statements related to the various categories of Enablers and Results of the SE model. Given the exploratory nature of the survey we decided to replace the missing data with "worst-case" assumption of "Absent" (see Response categories in Table A1).

Very few responses were received from respondents for the following questions and it was therefore decided to omit these questions entirely from the data analysis:

Question (Section/Number)	*Topic*
Section A Question 2	Number of indirect employees
Section C Question 2	Usage of performance measures
Section C Question 3	Current development cost structure
Section C Question 4	Financial performance
Section D All questions	Global operations

The lack of responses on the above questions can be attributed to the reluctance of respondents to part with financial information, the low usage of quantitative measures of SPU performance and the lack of global operations on the part of the respondents.

Profile of Software Producing Units

Companies were asked to classify themselves as either a company, a department, a division or as an "other" category. About 60% of the respondents were SPUs which were a division or a department within a larger organizational unit while 40% were autonomous companies.

A breakdown of the home-countries of the respondents is as follows: France (12), Ireland (12), Germany (10), Finland (8), Switzerland (8), Great Britain (7), Spain (6), Sweden (4), Belgium (3), Croatia (3), Italy (2), Netherlands (2), USA (2), Austria (1), Denmark (1), Iceland (1), Mexico (1), Portugal (1) and Russia (1).

A sectorial breakdown of the responding SPUs is as follows: IT activities (58%), Business (16%) and Manufacturing (12%). Individual SIC codes were not taken as the base unit of differentiation among companies because of the small sample size.

Fifty two out of the 85 respondents (60%) have less than 100 employees. At the other end of the spectrum, there are a few very large firms (only 8 companies have more than

10,000 employees). Twenty seven companies out of 78 (almost 35%) have less than 10% of the total number of employees in software-related jobs.

With respect to the development categories for the respondents (each respondent could tick multiple categories if applicable), the largest number are from the Electronic Data Processing/Management Information Systems domain (50), followed by Transaction Processing (40), Decision Support Systems (32), Control Systems (27), Telecommunications (25), Production Systems (20) and Software Development Products (16). This shows that a majority of surveyed companies are involved in developing software applications to support business needs. In fact, 71% of the respondents were working in at least one of the top three categories.

Customized Software Development is the largest percentage (38%) of the portfolio of software activities for the responding SPUs, although this number is expected to decline slightly (to 33%) in the next year. The next three major categories of software activities for the responding SPUs are Software Product Development (28%), Maintenance (28%) and Embedded Applications (25%).

An analysis was done of the distribution of project work among the various software life cycle activities. The maximum amount of time (27%) is being spent by the respondents on coding and unit testing. Upstream activities such as Requirements (11%) and Planning/Specifications (13%) are getting less emphasis while more emphasis is being given to activities like System Testing (17%) and Maintenance (16%).