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Executive Summary
Previous IS research has shown that maintenance staff related concerns (as distinct for example from technological concerns) are amongst the more important problems in software maintenance. In particular, the attitudes of maintenance staff towards their work can have adverse effect on their performance and the quality of the application portfolios they help to sustain. This paper reports on a study of Singapore maintenance personnel who are actively involved in maintaining application systems, or whom directly supervise the maintenance process.

The study suggests that Singapore maintenance personnel have a more adverse view of maintenance than their U.S. colleagues. In particular, Singapore maintenance personnel neither find their job challenging nor responsible. They also believe that their development colleagues are better paid and have better promotion prospects. These findings reinforce findings from Couger's 1985 cross-cultural study [Couger, 1989] which compared the motivation of Singapore analysts and programmers against that of their North American counterparts. As part of national planning, the then Singapore National Computer Board contracted Couger-Zawacki and Associates to conduct a comprehensive study of software capabilities. Couger observed that Singaporean analysts perceived their jobs to be less challenging than did their U.S. counterparts and that maintenance work was seen to be highly undesirable in both settings.

A possible reason for the low status accorded to maintenance is the adoption of inappropriate IS personnel practices that deny maintainers what Couger and Colter [1985: pp.8] refer to as "meaningfulness in the work". In an earlier study [Tan and Gable, 1995], the authors found that Singapore IS organisations tend to treat maintenance as a training ground and mistakenly assign new personnel to the function. Such action can only wrongly signal to these staff that maintenance is an insignificant task; one that can be safely allocated to newcomers. In the current study, several respondents complained that their IS departments do not practice enough job rotation and this deprived them of opportunities to exercise their different skills and talents. Still, other respondents indicated that they were asked to simultaneously develop new systems and maintain existing ones, the result being that the maintainers are unable to experience the completion of a "whole and identifiable piece of work"[Couger and Colter, 1985: pp.8]. Needless to say, all these practices have demoralising effects on the maintenance personnel and cause them to take a low view of their job.

The other intriguing finding from the study is the contrasting views of maintenance personnel and maintenance managers regarding the ranking of the problem areas. While the maintainers perceive that the managers have not or have inadequately implemented suitable maintenance processes to facilitate their work, the managers, on the other hand, singled out maintenance personnel issues as their main obstacle in the achievement of their goals. The managers also alluded to the attitude of senior management towards maintenance as manifested in their comments about the difficulty of redressing the inadequacy of maintenance personnel resources. It could be argued that both maintenance personnel and managers are actually looking at a common issue but from two different perspectives. That is, that rapid computerisation in Singapore has drawn much IS resources away from maintenance to development. With senior management and user's preoccupation with new development, usually in the name of strategic advantage, Singapore IS managers are unlikely to pay

much attention to maintenance. This is born out in the level of attendance at the Institute of Systems Science where courses providing skills in developing new applications are highly popular while those supporting maintenance see much lower demand.

Fast-paced computerisation has given rise to intense competition among IS organisations for technical personnel which has in turn resulted in substantial and perennial staff turnover, the bane of Singapore IS managers. This is a common observation among the various Singapore studies [e.g. Tan & Igbaria, 1994]. The shortage of computer personnel is so acute that the recent study by Singapore National Computer Board [1996] reported a growing need in several sectors to consider outsourcing to fulfill their IS manpower requirements. Besides this option, Singapore IS managers have also looked to new college graduates to redress the shortage. The approach of hiring inexperienced though technically competent personnel has the drawback that these new entrants generally lack the business knowledge and skills to undertake maintenance effectively. Moreover, being young these new hires have high expectations of career prospects and rewards. Combined with the shortage of staff, low experience level of new staff, the impatience of IS personnel to advance and low status of maintenance work, Singapore IS managers find the upkeep of their application portfolios a grueling task

Introduction

Software maintenance is defined as all changes performed on operational application systems to correct faults, to adapt to a changed environment or to improve performance or other attributes [ANSI/IEEE Standards 610.12-1990]. These changes are necessary and crucial to organisations as they ensure that the application systems which support their key business processes remain consistent with internal and external conditions. Nevertheless, despite the fact that software maintenance is now better researched and understood than ever before, it has never received the same attention as software development.

Several key studies in the past have rendered valuable insight into problems in managing software maintenance. Researchers like Lientz & Swanson [1980], Martin & Osborne [1983], Chapin [1985], Swanson & Beath [1989], Dekleva [1992] and, more recently, Dart et al. [1993] have shown that these maintenance problems have both technological and non-technological bases. Several of these studies further suggest that issues associated with maintenance staff are equally important to those associated with maintenance activities, maintenance tools & techniques, and user or senior management support.

This paper reports on an investigation of the attitudes of Singapore maintenance personnel towards maintenance work and also analyses how their perceived maintenance problems differ from those of IS managers. Findings of the study are compared against results of earlier research involving Singapore maintenance managers and also against data from several United States studies.

Investigation Approach

The investigation was carried out among attendees at a software maintenance course conducted by the Institute of Systems Science, a training institute that provides continuing IT education for practicing computer professionals in Singapore. A one-page questionnaire, which was adapted from that used in Dekleva's [1992] Software Maintenance Association (SMA) survey, was distributed to selected attendees at the start of the course. These attendees have job titles like analyst programmer, systems analyst and software engineer, which suggest that they are directly involved in the maintenance activity.

The questionnaire comprised 4 parts. Part one contains general questions about the respondent's organisation while part two queries how maintenance personnel are organised in the IS department. Part three explores the relative opportunities offered by and the relative demands required of software maintenance versus software development. Part four is based on two open-ended questions inviting respondents to state three major maintenance problems and three maintenance changes they would like to see implemented in their organisations. The format used by Dekleva [1992] was adopted to facilitate comparison with his North American results.

Forty-seven valid responses were solicited over several runs of the course.

Results

Background of the Respondents

Table 1 shows that three-quarters of the respondents are maintenance programmers while the rest are project leaders who direct the maintenance team. Two-thirds are from the private sector while the remaining one-third are from various government organisations. The majority of the respondents were from mainframe installations and 43% have more than 100 IS employees.

Table 1: Demographic Data of Respondents (N=47)

	Frequency	Percent
Respondent's Profile		
Maintenance Programmer	34	72
Team Leader	13	28
	47	100
Industry Type		
Financial Services	3	6
Government	18	38
Transportation	12	26
Utility/Telecommunication	4	9
Computer-Related	9	19
Healthcare	1	2
	47	100
Number of IS Employees		
< 20	8	18
21 to 40	8	18
41 to 60	6	14
61 to 80	3	7
81 to 100	0	0
> 100	19	43
	44*	100
Installation Type		
Mainframe	31	66
Minicomputer	16	34
	47	100

* Did not add up to 47 due to missing data.

Organisation of Software Maintenance

Table 2 shows how respondents described the organisation of software maintenance in their IS function. Thirty-one percent of respondents reported they are organised into separate groups, each having its own manager. Thirty percent indicated that the IS personnel in their companies are assigned either to development or to maintenance but within the same group. Eleven percent of respondents belong to organisations that practice staff rotation between the two functions, while 62% stated that IS personnel develop and maintain application systems at the same time.

Table 2: Software Maintenance Organisation

	Frequency	Percent
Separate groups, each group has its own manager	31	66
Same group but separate assignments	14	30
Rotating assignments	5	11
Simultaneous development and maintenance	29	62

Morale and Skills Issues

Table 3 summarizes the respondents' answers to various measures of morale and skills issues. The results are further compared with those obtained by Dekleva in his 1990 SMA survey. It is noted that both studies concentrated on personnel who actively maintain application systems or whom directly supervise the maintenance process.

Table 3: Opportunities and Demands from Software Maintenance: Singapore vs United States

	Tan & Gable 1995 (N=47)			Dekleva 1990 (N=59)		
	Mtce %	Devt %	Same %	Mtce %	Devt %	Same %
Opportunities: ... which offers more						
Responsibility	30	19	51	76	2	22
Personal satisfaction	0	89	11	40	28	33
Challenge	6	68	26	66	9	26
Learning opportunity	11	68	21	40	33	28
Career growth	4	77	19	12	59	29
Exposure to management	4	68	28	17	62	21
Salary	2	45	53	3	26	71
Average	8	62	30	36	31	33
Demands: ... which demands more						
Experience	36	30	34	78	14	9
Ability to interact with people	15	38	47	71	5	24
Problem-solving skills	55	11	34	88	0	12
Programming skills	21	34	45	48	10	41
Design skills	0	77	23	17	55	28
Knowledge of user business	15	23	62	38	12	50
Intuition	26	19	55	78	3	19
Average	24	33	43	60	14	26

In six of the seven opportunity measures, respondents indicated that development offers greater opportunity than maintenance, thus suggesting that Singapore maintainers view maintenance as being relatively undesirable. This trend is less clear in Dekleva's data. Furthermore, the majority of Singapore maintainers, unlike their US counterparts [Dekleva, 1992], did not find maintenance more responsible and challenging than development. While U.S. maintainers feel that both jobs are paid about the same, Singapore maintainers are less inclined to share this sentiment. However, maintainers in both countries seem to have the common notion that development offers more in terms of career growth and exposure to management.

Overall, Singapore respondents seem to perceive little difference in the capability demands of maintenance versus development (24% vs. 33%). In contrast, Dekleva's study shows that U.S. maintainers view maintenance as being more demanding than development (60% vs. 14%) especially in terms of experience, ability to interact, problem-solving skills, and intuition. Both Singapore and U.S. respondents tend to regard design skills as more critical in new systems development than in maintenance although this conviction appears to be stronger in the Singapore case. Both also believe that maintenance and development require knowledge of user business.

Problems Experienced and Change Desired

Table 4 summarizes the 121 responses (2.6 statements per respondent) to the open-ended prompt "What are the three major software maintenance problems in your IS department?". As the responses vary widely, they were first condensed into logical groupings and the results later used to populate the empirical problem categories that were first used by Chapin [1985] and later adopted by Dekleva [1992] in his SMA annual survey: (1) maintenance management, (2) systems characteristics, (3) personnel factors, (4) user relations, and (5) environmental factors. It is found that the majority of the problems reported (38%) are attributed to maintenance management or the management of the

maintenance process. Problems relating to the application software (labeled here as system characteristics) and personnel factors, constitute 31% and 17% of the responses respectively. Interestingly, user problems are not viewed as important (11%) while those associated with environmental factors are seen as even less so.

Table 4: Categories of Problems Experienced

Problems Experienced	Frequency	Percent	
Maintenance Management			
Maintenance standards	8	6.6	
Maintenance tools	7	5.8	
Meeting scheduled commitments	7	5.8	
User change procedures	6	5.0	
Configuration management	6	5.0	
Release controls	3	2.4	
Testing procedures	2	1.7	
Change cost justification	2	1.7	
Program change controls	2	1.7	
Budgetary pressures	2	1.7	
Maintenance measurement	1	0.8	38.2
System Characteristics			
Quality of documentation	19	15.6	
Unstructured programs	6	5.0	
Aging systems	5	4.1	
Quality of original programming	3	2.4	
Adequacy of application design spec.	3	2.5	
Storage requirements of programs	1	0.8	
Application software run failures	1	0.8	31.2
Personnel Factors			
Skills of maintenance personnel	6	5.0	
No. of maintenance personnel available	6	5.0	
Turnover of maintenance personnel	4	3.3	
Motivation of maintenance personnel	4	3.3	16.6
User Relations			
User demand for enhancement	5	4.1	
Management support	5	4.1	
Lack of user understanding	2	1.7	
Unrealistic user expectations	1	0.8	10.7
Environmental Factors			
Dynamic business change	4	3.3	3.3
	N=121	100.0	100.0

Table 5, which was derived in the same manner as Table 4, summarizes the 102 responses (2.2 statements per respondent) to the question: "If you could change three things about software maintenance in your IS department, what would they be?". Not unexpectedly, the results in Table 5 mirror those in Table 4 although there are some differences in the percentage distributions. Respondents expressed a stronger desire for changes to maintenance management (50% vs. 38%). Calls by respondents for improvements to system characteristics (26%), personnel factors(14%) and user relations (10%) are of about the same magnitude as in Table 4.

Table 5: Categories of Changes Desired

Changes Desired	Frequency	Percent	
Maintenance Management			
Maintenance tools	12	11.8	
Maintenance standards	11	10.8	
Configuration management	9	8.8	
User change procedures	5	4.8	
Maintenance measurement	4	3.9	
Change cost justification	2	2.0	
Release controls	2	2.0	
Maintenance organisation	2	2.0	
Outsourcing of maintenance	2	2.0	
Maintenance techniques	1	1.0	
Scheduling of personnel time	1	1.0	50.1
System Characteristics			
Quality of documentation	12	11.8	
Program maintainability	5	4.8	
Revamp of hard-to-maintain systems	4	3.9	
Application software run failures	3	2.9	
Storage requirements of programs	1	1.0	
Quality of original programming	1	1.0	
Adequacy of application design spec.	1	1.0	26.4
Personnel Factors			
Skills of maintenance personnel	6	5.9	
No. of maintenance personnel	4	3.9	
Motivation of maintenance personnel	3	2.9	
Turnover of maintenance personnel	1	1.0	13.7
User Relations			
User interest	4	3.9	
User training	3	2.9	
Management support	2	2.0	
Report enhancement done by user	1	1.0	9.8
	N=102	100.0	100.0

Table 6 compares Singapore results with Dekleva [1992] and Chapin [1985] findings. It is observed that Singapore and Dekleva data exhibit similar patterns. That is, the order of concern is: maintenance management, system characteristics, personnel factors and user relations. These two sets of results, however, contrast with Chapin's earlier results which highlighted problems with the application software.

Table 6: Comparison of Singapore, Dekleva 1990 and Chapin 1984 Studies

Problem Categories	Tan & Gable 1995		Dekleva 1990		Chapin 1984
	Problems Experienced %	Changes Desired %	Problems Experienced %	Changes Desired %	Problems Experienced %
Maintenance management	38	50	28	49	9
System characteristics	31	26	21	15	48
Personnel factors	17	14	19	18	19
User relations	11	10	5	3	5
Environmental factors	3	0	19	14	8
Maintenance activities	0	0	4	0	7
Miscellaneous	0	0	4	1	0

Comparison of Maintenance Personnel and Maintenance Manager Perceptions

In an earlier study [Tan & Gable, 1995], the authors surveyed Singapore maintenance managers using a modified version of Lientz & Swanson's original [1980] instrument and their pre-defined 26 problems. Table 7 reports results of grouping the resultant 26 problem scores into Chapin's problem categories. From the category scores, personnel factors are found to emerge at the top of the maintenance managers' list of issues (category score = 3.12). In contrast, Table 4 indicated that the chief concern of the maintainers is the poor management of the maintenance work. It thus appears that maintenance personnel and managers are faulting each other for the woes they each are experiencing. Further analysis of the two tables reveals that while the maintainers see application software as the second major contributor to the maintenance problem, maintenance managers are less inclined to hold this opinion. Both groups, however, consider user relations as an issue warranting relatively lesser attention.

Table 7: Summary of Singapore Maintenance Managers Data [Tan & Gable, 1992]

Rank	Problems[1]	Score[2]	Average Score
Personnel Factors			
4	No. of maintenance programmers available	3.27	
7	Maintenance personnel turnover	3.23	
9	Skills of maintenance personnel	3.06	
12	Maintenance programmer motivation	2.92	3.12
Maintenance Management			
2	Competing demands for programmer time	3.43	
3	Meeting scheduled commitments	3.40	
14	Maintenance programming productivity	2.85	
16	Forecasting maintenance pgmr requirements	2.76	
17	Budgetary pressures	2.71	
18	Adherence to programming standards	2.70	2.98
User Relations			
1	User demand for enhancements	3.66	
6	Unrealistic user expectations	3.26	
10	Turnover in user organisation	3.00	
13	Lack of user understanding	2.90	
15	Inadequate user training	2.82	
21	Lack of user interest	2.39	
23	Management support	2.29	2.90
System Characteristics			
5	Documentation quality	3.26	
8	Quality of original programming	3.21	
11	Adequacy of system design specification	2.98	
19	Program processing time requirements	2.64	
20	Data integrity in application software	2.58	
22	Application software run failures	2.37	
24	System hardware and software changes	2.17	
25	Hardware and software reliability	1.99	
26	Program storage requirements	1.89	2.57

1. Lientz & Swanson's [1980] original 26 problems
2. 5-point rating scale ranging from 1="No Problem At All" to 5="Major Problem" was used

Discussion of Results

The study suggests that Singapore maintenance personnel have a more adverse view of maintenance than their U.S. colleagues. In particular, Singapore maintenance personnel neither find their job challenging nor responsible. They also believe that their development colleagues are better paid and have better promotion prospects. These findings reinforce findings from Couger's 1985 cross-cultural study [Couger, 1989] which compared the motivation of Singapore analysts and programmers against that of their North American counterparts. As part of national planning, the then Singapore National Computer Board contracted Couger-Zawacki and Associates to conduct a comprehensive study of software capabilities. Couger observed that Singaporean analysts perceived their jobs to be less challenging than did their U.S. counterparts and that maintenance work was seen to be highly undesirable in both settings.

The literature abounds with reports of such negative views of the maintenance task. Couger-Colter's extensive survey [Couger & Colter, 1985] among 500 persons in 10 organisations, and later on-site interviews with 104 analysts, programmers and mangers, attested to this notion. Martin & Osborne [1983], who based their work on selected U.S. Federal agencies and private sector organisations, also noted the common complaint by maintenance personnel that software maintenance is unimportant, unchallenging, unrewarding, uncreative work which is seldom appreciated. Layzell and Macaulay [1994] found from their study of 5 major companies in the United Kingdom that some organisations had "difficulty in recruiting younger staff to the maintenance function". A recent study by Dart et al. [1993] at an unspecified U.S. government agency also revealed that maintenance is not treated as a prestigious job but they found that those who choose to carry out maintenance see it as a "most challenging task".

The low prestige that Singapore maintenance personnel attach to maintenance is among other undesirable IS personnel issues that flow from the rapid pace of computerisation in Singapore. Several Singapore studies have previously investigated these issues. Tan & Igbaria [1994] argue that high turnover among Singapore computer professionals is due to competition from employers who offer higher remuneration, and to perceived limited advancement opportunities. Chan et al. [1993] observe that challenging work, greater autonomy, improved career opportunities and better pay are some of the goals that IS and other professionals work towards. In the case of computer professionals, such inducements are even more necessary. Singapore computer professionals are highly mobile due to demand exceeding supply. Thus, better pay and advancement opportunities in system development work appear to promote job change. To exacerbate the situation, Loh et al. [1995] demonstrated that the level of job satisfaction is lowered when technically-oriented Singapore IS professionals, believing that there are better rewards and prospects in managerial positions, aspire to move into management sooner than they are ready.

Another plausible reason for the low status accorded to maintenance is the adoption of inappropriate IS personnel practices that deny maintainers what Couger and Colter [1985: pp.8] refer to as "meaningfulness in the work". In an earlier study [Tan and Gable, 1995], the authors found that Singapore IS organisations tend to treat maintenance as a training ground and mistakenly assign new personnel to the function. Such action can only wrongly signal to these staff that maintenance is an insignificant task; one that can be safely allocated to newcomers. In the current study, several respondents complained that their IS departments do not practice enough job rotation and this deprived them of opportunities to exercise their different skills and talents. Still, other respondents indicated that they were asked to simultaneously develop new systems and maintain existing ones, the result being that the maintainers are unable to experience the completion of a "whole and identifiable piece of work"[Couger and Colter, 1985: pp.8]. Needless to say, all these practices have demoralising effects on the maintenance personnel and cause them to take a low view of their job.

Interestingly too, the current study indicates that Singapore maintainers do not seem to share the same belief as their U.S. counterparts that maintenance requires more skill than does development. One of the commonly held notions among maintenance researchers is that maintenance requires more skills than development because maintainers have to work within many constraints, such as the limitations of existing code. This appears to be less valid in the case of Singapore. A likely explanation is the relative youthfulness of the typical application portfolio in Singapore as compared to those in the U.S. [Tan & Gable, 1995]. Young application software tends to require less effort to modify as the programs have not yet deteriorated through ill and prolonged patching. In the same study by the authors, it was also observed that a large number of the application portfolios surveyed were based on fourth-generation programming languages (4GLs) which, according to Martin & McClure [1983], promote maintenance productivity as they simplify code modification. Other explanation can be found in the recently completed manpower and skills inventory survey report by the Singapore National Computer Board [1996] which noted that Singapore IS professionals generally possess proficient structured analysis and design skills. It could be inferred that this enables Singapore developers to produce applications that are more conducive to future change.

The other intriguing finding from the current study is the contrasting views of maintenance personnel and maintenance managers regarding the ranking of the problem areas. While the maintainers perceive that the managers have not or have inadequately implemented suitable maintenance processes to facilitate their work, the managers, on the other hand, singled out maintenance personnel issues as their main obstacle in the achievement of their goals. The managers also alluded to the attitude of senior management towards maintenance as manifested in their comments

about the difficulty of redressing the inadequacy of maintenance personnel resources. It could be argued that both maintenance personnel and managers are actually looking at a common issue but from two different perspectives. That is, that rapid computerisation in Singapore has drawn much IS resources away from maintenance to development. With senior management and user's preoccupation with new development, usually in the name of strategic advantage, Singapore IS managers are unlikely to pay much attention to maintenance. This is born out in the level of attendance at the Institute of Systems Science where courses providing skills in developing new applications are highly popular while those supporting maintenance see much lower demand.

Fast-paced computerisation has given rise to intense competition among IS organisations for technical personnel which has in turn resulted in substantial and perennial staff turnover, the bane of Singapore IS managers. This is a common observation among the various Singapore studies [e.g. Tan & Igbaria, 1994]. The shortage of computer personnel is so acute that the recent study by Singapore National Computer Board [1996] reported a growing need in several sectors to consider outsourcing to fulfill their IS manpower requirements. Besides this option, Singapore IS managers have also looked to new college graduates to redress the shortage. The approach of hiring inexperienced though technically competent personnel has the drawback that these new entrants generally lack the business knowledge and skills to undertake maintenance effectively. Moreover, being young these new hires have high expectations of career prospects and rewards. Combined with the shortage of staff, low experience level of new staff, the impatience of IS personnel to advance and low status of maintenance work, Singapore IS managers find the upkeep of their application portfolios a grueling task.

Conclusions

The findings from the study generally suggest that Singapore IS professionals' perceptions of maintenance are more adverse than was previously thought. The root cause appears to be massive on-going computerisation in Singapore that tends to lure IS professionals to better paying and more visible development jobs, much to the detriment of the maintenance function. The situation is further exacerbated, firstly, by some organisations adopting inappropriate personnel practices that lead to low morale among the maintenance staff and, secondly, by the tendency of the younger IS staff to change jobs in their eagerness to forge ahead in their careers.

The undesirability with which Singapore IS professionals view maintenance would persist, or even worsen, if the current demands for new systems continues to produce a tight labour market for development personnel. Nonetheless, IT policy-makers, corporations and institutions in Singapore can help to alleviate the problem by adopting some of the corrective steps previously proposed by other software maintenance researchers. These include IT according equal status to maintenance and development including monetary rewards, better defined career paths, and tertiary institutions educating new entrants on the challenges as well as importance of software maintenance.

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