Information Technology Management in Asia-Pacific Central Government Agencies

C.S. YAP
K.S. RAMAN
C.M. LEONG

NATIONAL UNIVERSITY OF SINGAPORE

ABSTRACT

Central government agencies in Asia-Pacific countries have become major users of information technology (IT) during the last decade. Yet relatively little information is available on management of IT infrastructure and computer systems in these agencies. This paper presents the findings of a study on four aspects of IT management practice in central government agencies in five Asia-Pacific countries at different stages of economic development. The findings show that IT management practices in the more developed countries tend to be more advanced. Computer installations in central government agencies in these countries make better use of computing resources, emphasize information systems (IS) planning and integration of IS plans and business plans, and make greater use of standards in systems development. Installations across the five countries rate their training of users and disaster recovery capability low. Some areas for further research on IT management practice in government agencies are identified.

INTRODUCTION

Information technology (IT) has been used extensively in the government sector in developed countries for internal operations and delivery of services to the public since the 1960s. Around the same period, governments of Asia-Pacific countries started to use computers in an ad-hoc manner as number crunching devices. In the 1980s, some Asia-Pacific countries recognized the important role IT can play in economic development and improving operations of government agencies and started to use IT extensively in a planned manner. The rapidly declining cost of hardware, emergence of the personal computer (PC) as a business tool, availability of user friendly software and application packages, and the increase in the number of IT professionals had a very positive influence on the use of computers by government agencies in these countries. Today, almost all government agencies — local, state, and central — in Asia-Pacific countries use IT in some way.

Several factors seem to motivate the use of IT products and services in governments in Asia-Pacific countries. King and Kraemer [5] suggest that the use of IT in governments is motivated by need, but occurs only when there is opportunity. A review of available material shows that the need varies from country to country and varies within a country at different stages of introducing IT. In Hong Kong, the main motivations for increasing use of IT in government are to enhance the overall public service effectiveness in the context of continual growth in population, expansion of government activities, heightened expectations of a better educated and informed public, and the demand for efficient services to support the commercial and industrial sectors vital to its economy [2]. In Malaysia, the objectives of using IT in government include improving efficiency in government administration, enhancing managerial effectiveness, improving delivery of government services, promoting availability of and access to government information, creating greater awareness of IT in the country, and supporting the shift in the country's economy from the agricultural sector to the information intensive industrial and service sectors [10, 13]. In Singapore, the main motivation in the first stage of computerization was to reduce or avoid manpower need in government and speed up administrative processes through the Civil Service Computerization Programme (CSCP) and promote local IT industry through procurement policies. The second stage focused on fundamentally changing the way activities were carried out in the civil service using IT for

coordination across civil service and beyond into the private sector [1, 3]. In South Korea, the objectives of government computerization are simplification of administrative structure, improvement in civil service administration, support in policy decision making, and improvement in public service [4]. In some of these countries, government computerization programs have also acted as catalysts to jump start the supply side of IT products, services, and professionals.

In order to achieve their objectives, governments of Asia-Pacific countries have made substantial investments annually in IT. Some available figures are: Malaysia US$70 million in 1992 [10]; Singapore US$125 million in 1994 and a similar amount in 1993 [11]. These investments in IT have resulted in large computer installations with sophisticated computer and communication hardware, software, and large teams of professional IT staff. Effective management of this sophisticated IT infrastructure has become crucial to meet the objectives of government computerization programs.

The literature on IT management has so far focused mostly on private sector organizations and relatively little attention has been paid to management of IT in the government sector. Because there are some fundamental differences between private and government sector organizations in objectives, environment, organization-environment transactions, and internal structures and processes [12], there are reasons to believe that IT management practices in the government sector would be different from those in the private sector. This paper reports on the IT management practices in central government agencies in Australia, Hong Kong, Malaysia, Singapore, and South Korea. It describes and compares (using descriptive statistics) four aspects of IT management: (1) availability of computer systems; (2) performance of computer installations; (3) systems development practices; and (4) information systems (IS) planning and control.

LEVEL OF ECONOMIC DEVELOPMENT

In order to facilitate analysis and interpretation of the findings, the five countries are divided into Developed, Newly Industrialized, and Developing based upon their level of economic development (Table 1). In the course of describing the similarities and differences among the five countries in the analysis, we focus on the extent to which differences can be attributed to the level of economic development.

Table 1
Classification of Countries by Level of Economic Development

Developed	Newly Industrialized	Developing
Australia	Singapore	Malaysia
	Hong Kong	
	South Korea	

Table 2 shows the demographic, economic, and IT investment data for each country. It can be seen from the population figures that the countries vary considerably in size using population as a measure. As can be expected, there is no association between population size and the level of economic development. Investment in IT seems to be related to the level of economic development as measured by per capita gross domestic product (GDP). This relationship is consistent with the findings of Kraemer, Gurbaxani and King [9] that the level of economic development is an important factor in determining computer use across countries.

THIS RESEARCH

The research reported here is part of the larger longitudinal research project "International Study of Government

Table 2
Characteristics of Countries

	Developed	Newly Industrialized			Developing
Characteristics	**Australia**	**Singapore**	**Hong Kong**	**South Korea**	**Malaysia**
Population, 1990 (in millions)[1]	17.1	3.0	5.8	42.8	17.9
GDP per capita, 1990 (US$)[1]	$17,327	$11,533	$10,288	$ 5,523	$ 2,369
Total GNP, 1990 (US$, in billions)[1]	$291	$ 33	$ 67	$231	$ 42
IT investment as % of GDP, 1990[2]	2.03	1.84	1.19	0.91	0.67

Source: [1] World Bank [14]
[2] Kraemer and Dedrick [8]

Table 3
Sample Size by Type of Agencies

	Developed	Newly Industrialized			Developing	
Installation	Australia	Singapore	Hong Kong	South Korea	Malaysia	Total
Central government	36	17	39	20	60	172
Other	8	20	6	118	119	271
Total	44	37	45	138	179	443

Policy and Information Technology in Asia-Pacific Countries" jointly carried out by the National University of Singapore and the University of California, Irvine [6]. The aim of this research was to gain insight into the IT management practices in central government agencies through a census survey. At the very outset it was realized that data collection for this research would be difficult. The initial strategy explored for collecting data was to use the available secondary data, but at the time of starting the research in 1988/89, there was no consistent set of secondary data available across the five countries. Some countries had carried out their own studies on IT, but the data were not suitable for the purposes of this research for several reasons. First, there was no common focus in these individual studies; second, the studies were conducted in different years; and third, the definitions and meanings of some terms varied widely across countries. Therefore, for purposes of this research and the larger project, a standard "Computer Installation Questionnaire" was designed to collect the data.

It was also realized that an efficient and effective data collection and communication strategy covering the five countries was critical to this project. Therefore, the research team identified a senior central government IT executive (called Country Expert in this project) in each country and enlisted his/her support for the project. The research team visited each country and discussed the project and the questionnaire with the Country Expert and senior government officials involved in IT and incorporated their suggestions into the final questionnaire. The Country Experts administered the questionnaires to government computer installations in their countries and returned the completed questionnaires to the research team at the National University of Singapore for analysis. The research team held three conferences of Country Experts in Singapore and discussed the research, its progress, and findings at important milestones of the project.

THE SAMPLE

A total of 443 questionnaires was returned by the five countries covering central government agencies, government corporations and enterprises, universities and colleges, state/provincial governments, and local governments (Table 3). In order to make comparisons among similar units, this paper focuses on the returns of 172 computer installations from central government agencies. The data presented here reflect the status of computer installations in central government agencies of the five countries in 1990/91.

Computer Installations

The unit of data collection and analysis in this research is a computer installation. For purposes of this research, a computer installation was defined as a more or less independent set of equipment and staff. Most agencies have a single, central computer installation, which may contain more than one computer and more than one type of computer, such as a mainframe, minicomputer, and several PCs. However, some large agencies may have a main installation and several satellite installations, usually in another location.

Technology Platforms

The technology platform of an installation can be mainframe, minicomputer, PC, or a combination of these. Because management practices for each IT platform may have some unique emphasis (e.g., systems programming in mainframe platforms), computer installations in this study were classified according to the following main technology platforms:

1. **Mainframe installation**, which was defined as an installation having at least one mainframe computer and any minicomputers or PCs associated with that installation;

2. **Minicomputer installation**, which was defined as an installation having at least one mainframe;

3. **PC installation**, which was defined as an installation having several PCs, either in a stand-alone mode or linked in a local area network, but no mainframe or minicomputers.

Table 4 shows the distribution of the installations according to the above technology platforms. From this table,

Table 4
Technology Platforms

	Developed	Newly Industrialized			Developing	
Technology Platform	Australia	Singapore	Hong Kong	South Korea	Malaysia	Total
Mainframe	17	9	8	3	14	51
Minicomputer	13	6	21	15	16	71
PC	6	2	10	2	30	50
Total	36	17	39	20	60	172

it is seen that the number of returns from South Korea is relatively small. Therefore, the findings for South Korea should be interpreted with caution.

Among the 172 central government computer installations, 51 (30%) are mainframe installations, 71 (41%) are minicomputer installations, and 50 (29%) are PC installations. In the following sections, we focus on the 122 mainframe and minicomputer installations because these tend to have an in-house IT department and have more established IT management practices. PC installations were generally smaller and were unable to provide many of the data requested for this study.

Mean Year When Computer Installations Began Operation

Table 5 shows the mean year when computer installations began operation for each technology platform in the five countries. The mean year is the "average" year when all computer installations of the same technology platform began operation. The progression within each country in the date when computer installations began operation is consistent with developments in technology. Mainframes were installed in late seventies and early eighties, followed by minicomputers and PCs. It is interesting to note that South Korea was first in using mainframe and minicomputers, but was late in adopting PCs.

ORGANIZATIONAL AND COMPUTING ENVIRONMENT

Because the computer installations studied in this research are an integral part of their client organizations, IT management practices will be influenced not only by the computing environment but also by the client organizational environment. The computing environment itself will be influenced by organizational factors such as size, mission, nature of work, and financial resources. In this section we look at the client organizations within which computer installations provide computing services, in particular those factors which might affect the demand for the services. We focus on two key attributes of the client organization and the computer installation, namely, number of employees and budgets, and data communications capabilities. Another key attribute of computing environment, technology platform, has been discussed earlier.

Size of Client Organization and Computer Installation

Table 6 shows the size of the client organization and the supporting computer installation, measured by mean number of employees and budget for mainframe and minicomputer technology platforms. It can be seen that client organizations

Table 5
Mean Year When Computer Installation Began

	Developed	Newly Industrialized			Developing
Technology Platform	Australia	Singapore	Hong Kong	South Korea	Malaysia
Mainframe	1977	1982	1978	1973	1981
Minicomputers	1985	1986	1984	1981	1983
PC	1986	1984	1985	1986	1985

Table 6
Mean Budget and Employees, 1990

	Developed	Newly Industrialized			Developing
Organizational Attributes	**Australia**	**Singapore**	**Hong Kong**	**South Korea**	**Malaysia**
Mainframe installations					
Budget (US$ millions)					
Client organization	852.5	233.6	189.9	424.6	17.4
IT	10.5	3.6	4.3	5.8	1.3
IT:client organization	1.2%	1.5%	2.2%	1.4%	7.5%
Employees					
Client organization	2,672	8,550	7,217	17,254	763
IT	103	66	143	521	101
IT:client organization	3.9%	0.8%	2.0%	3.0%	13.2%
Minicomputer installations					
Budget (US$ millions)					
Client organization	253.2	69.7	119.0	2,406.0	33.7
IT	2.1	0.8	1.5	0.4	0.9
IT:client organization	0.8%	1.1%	1.3%	0.02%	2.7%
Employees					
Client organization	1,042	212	3,456	3,616	6,916
IT	18	8	38	32	24
IT:client organization	1.7%	3.8%	1.1%	0.9%	0.3%

with mainframes, as well as their supporting computer installations, are larger and have higher budgets.

For mainframe installations, the IT budget ranges from a low of US$1.3 million for Malaysia to a high of US$10.5 million for Australia, and from 1.2% to 7.5% of the client organization budget. The number of IT employees ranges from 66 to 143, with the exception of South Korea, which has a mean size of 521. The proportion of IT employees to client organization employees ranges from 0.8% to 13.2%.

For minicomputer installations, the IT budget is lower than that of mainframe installations, ranging from US$0.4 million to US$2.1 million, with South Korea lowest and Australia highest. As a percentage of client organization budget, the IT budget ranges from 0.02% to 2.7%. There are also fewer IT employees in minicomputer installations, with Singapore having the lowest and Hong Kong the highest.

Table 7
Data Communication Capabilities, 1990

Percent of client	Developed	Newly Industrialized			Developing
organizations with capability	**Australia**	**Singapore**	**Hong Kong**	**South Korea**	**Malaysia**
Telex devices	83	77	52	42	52
Telefax devices	100	100	97	71	88
Modems	97	93	66	93	70
Leased lines for data communication	89	79	46	88	71
Connections for dial-up communication	100	93	25	27	30

Data Communications Capabilities

Data communications is considered a feature of the organizational computing environment. In some countries, data communications link government agencies at the same level and across central, state, and local levels. Some countries (e.g., Singapore) also link government and the private sector through Electronic Data Interchange (EDI) systems. These capabilities create demand for computing services within the client organizations because they generate the need for access to shared databases, file transfer, document transfer, and electronic communication.

Table 7 lists the data communications capabilities of the client organizations. Both Australia and Singapore show high similarity in the number of data communication outlets available to the client organization. In Australia and Singapore, the primary means of connection is through dial-up communications, while Hong Kong, South Korea, and Malaysia are more likely to have leased circuits. It is interesting to note that data communications capabilities in government agencies in Malaysia, a developing country, are as

Figure 1
Systems Availability

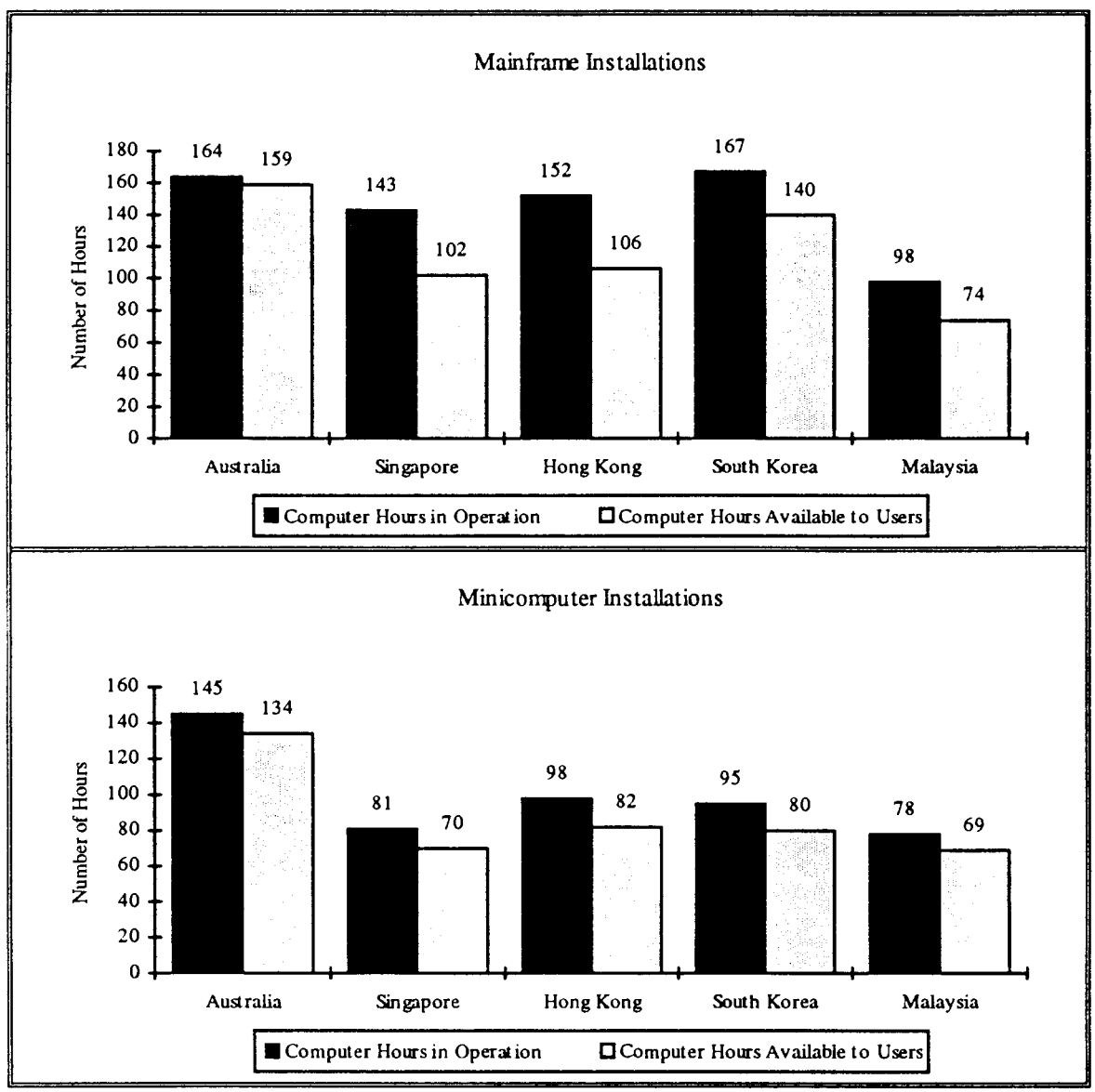


Table 8a
Performance Rating of Mainframe Installations

	Developed	Newly Industrialized			Developing
Dimension	**Australia**	**Singapore**	**Hong Kong**	**South Korea**	**Malaysia**
Overall Quality of Service	7.12	7.67	7.86	6.67	7.86
Helpfulness of Staff	7.53	7.67	8.43	6.67	8.50
Sophistication of Technical Environment	7.76	7.89	7.57	6.33	6.79
Management Relation with User Departments	6.82	7.78	8.57	6.33	8.14
Disaster Recovery Capability	5.29	5.22	6.86	6.00	6.23
Usefulness of Applications	7.47	7.89	8.57	7.00	8.46
Responsiveness of DP Management	7.41	8.11	7.85	7.00	8.71
Value for Money Spent	7.65	8.00	8.14	6.33	7.93
File Back-up Practices	7.94	7.78	8.57	8.33	8.07
Expertise of Staff	7.76	6.78	7.43	6.00	7.86
Training of Users	6.06	6.22	6.43	6.33	7.50
Relations with Top Management	6.88	7.44	8.43	8.00	7.93
Training of Computer Staff	6.94	7.78	7.00	5.50	7.64
Reliability of Hardware	7.94	7.89	8.42	7.00	7.50
Innovativeness of Applications	7.12	6.78	7.57	6.33	7.38
Utilization of Equipment Capacity	7.65	7.78	8.43	6.33	7.79
Planning for Future Growth	7.11	7.22	8.00	8.33	7.62

good as in Hong Kong, a country reputed to have a world class telecommunications infrastructure.

IT MANAGEMENT PRACTICES

This section presents the findings on IT management practices in computer installations in central government agencies of the five countries. The analysis focuses on four main areas: (1) availability of computer systems; (2) performance of computer installations; (3) systems development practices; and (4) IS planning and control.

Availability of Computer Systems

Figure 1 shows the number of hours per week when one or more mainframes or minicomputers in the installation are generally operational and the number of hours available to users. For mainframe installations, Australia and South Korea have long operational and availability hours, followed by Hong Kong, Singapore and Malaysia. For minicomputer installations, Australia has the longest operational and availability hours, followed by Hong Kong, South Korea, Singapore, and Malaysia. These figures indicate a possible association between operational and availability hours and the level of economic development. Countries which are more developed, such as Australia, tend to have longer operational and availability hours than developing countries such as Malaysia.

Performance of Computer Installations

Computer installation management involves not only managing the computer hardware, software and computer personnel, but also the relationship of the installation with user departments and top management. Hence, the performance of a computer installation can be measured along many dimensions. Each installation was asked to rate its own performance as compared to other similar computer installations with which it was familiar on 17 dimensions. Tables 8a and 8b show the results along these 17 dimensions for

Table 8b
Performance Rating of Minicomputer Installations

	Developed	Newly Industrialized			Developing
Dimension	**Australia**	**Singapore**	**Hong Kong**	**South Korea**	**Malaysia**
Overall Quality of Service	7.46	7.50	6.33	6.07	7.20
Helpfulness of Staff	7.92	8.17	6.95	6.27	7.80
Sophistication of Technical Environment	7.00	6.17	6.00	5.47	6.73
Management Relation with User Departments	7.00	8.17	6.95	5.40	7.53
Disaster Recovery Capability	6.69	3.60	6.62	5.71	6.47
Usefulness of Applications	7.23	7.67	7.40	5.73	7.93
Responsiveness of DP Management	6.85	8.17	7.05	6.62	7.60
Value for Money Spent	7.31	7.67	7.33	7.31	7.27
File Back-up Practices	8.31	8.00	7.29	7.23	7.53
Expertise of Staff	7.46	6.67	6.29	6.67	7.20
Training of Users	6.31	7.00	5.76	5.73	6.87
Relations with Top Management	7.15	8.33	6.81	6.93	7.80
Training of Computer Staff	6.92	8.00	6.26	5.50	6.73
Reliability of Hardware	8.54	7.67	6.92	6.23	7.53
Innovativeness of Applications	7.08	7.50	6.19	6.79	7.47
Utilization of Equipment Capacity	7.08	7.50	7.30	7.00	8.07
Planning for Future Growth	7.54	7.17	6.29	7.40	7.87

mainframe and minicomputer installations respectively.

A comparison across countries shows that for mainframe installations, Hong Kong ranks highest or second highest in 13 of the 17 performance dimensions. For minicomputer installations, Singapore ranks highest or second highest in 13 of the 17 performance dimensions, though it ranks lowest for disaster recovery capability. Installations in Australia appear to be the most sophisticated technically, with good file back-up practices, good technical expertise, and highly reliable hardware. Mainframe installations in Malaysia rate themselves highly in user relationships and utilization of equipment capability. The ratings of South Korean installations are consistently below average.

Overall, we can make the following observations. Computer installations in all countries surveyed do not rate themselves well on their disaster recovery capability and training of users. On the other hand, computer installations in all countries seem particularly comfortable with their file back-up practices and reliability of hardware.

Systems Development Practices

Application systems are usually developed in phases which include feasibility assessment, information requirements analysis, logical system design, physical system design, programming, implementation, maintenance, and post-implementation audit. Historically, computer installations have relied on in-house resources for these phases. In recent years, use of third party resources to varying degrees in these phases or outsourcing the entire systems development and operations have become viable alternatives. These alternatives are especially viable when computer installations face a shortage of IT manpower, have little experience, or find it more cost effective to engage outside resources. Another important aspect of systems development is the increasing emphasis on quality and productivity. This has necessitated the adoption of standards and the measurement of software development productivity.

Use of Third-Party Resources. Figure 2 shows the extent to

Figure 2
Use of Third Party Resources

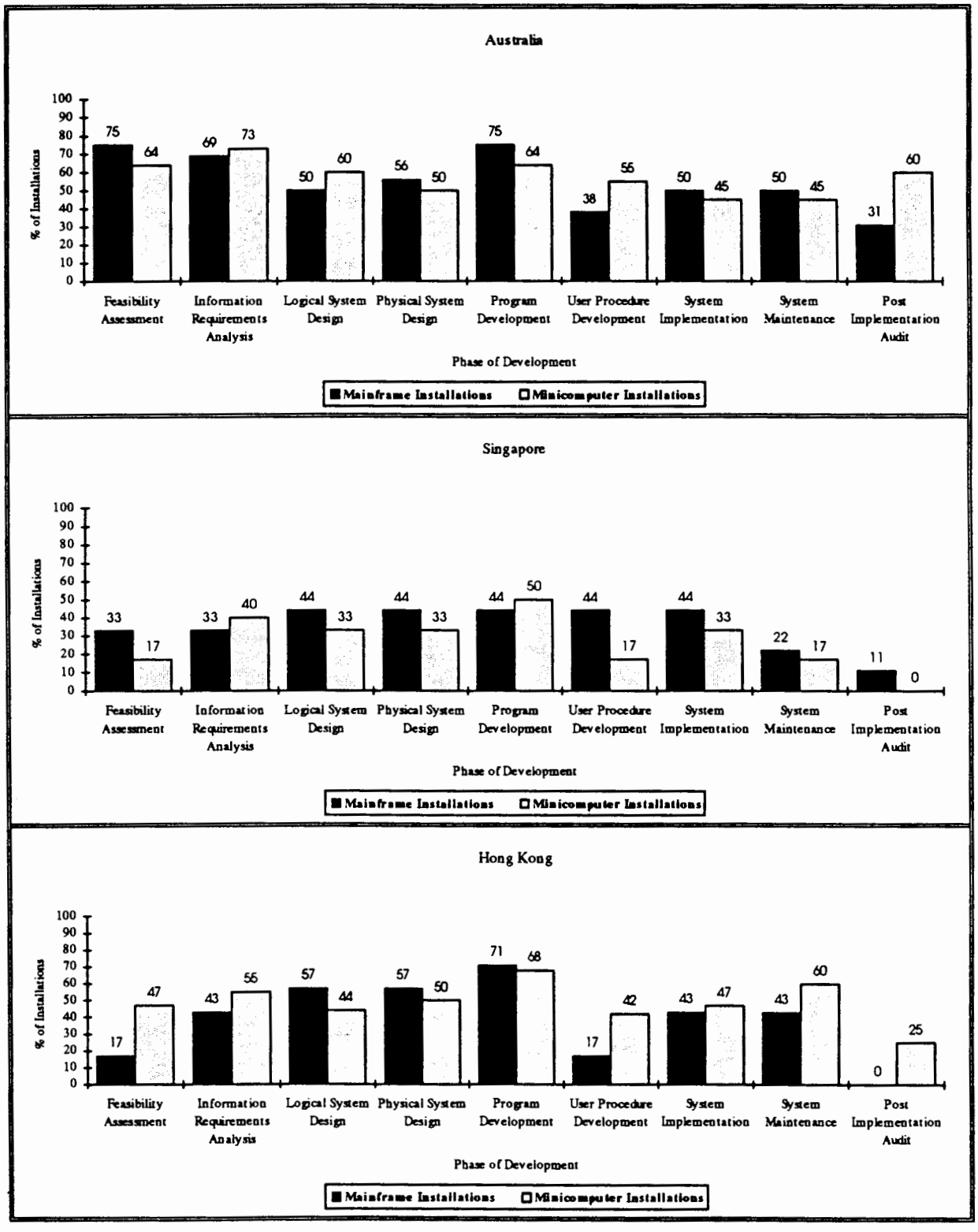
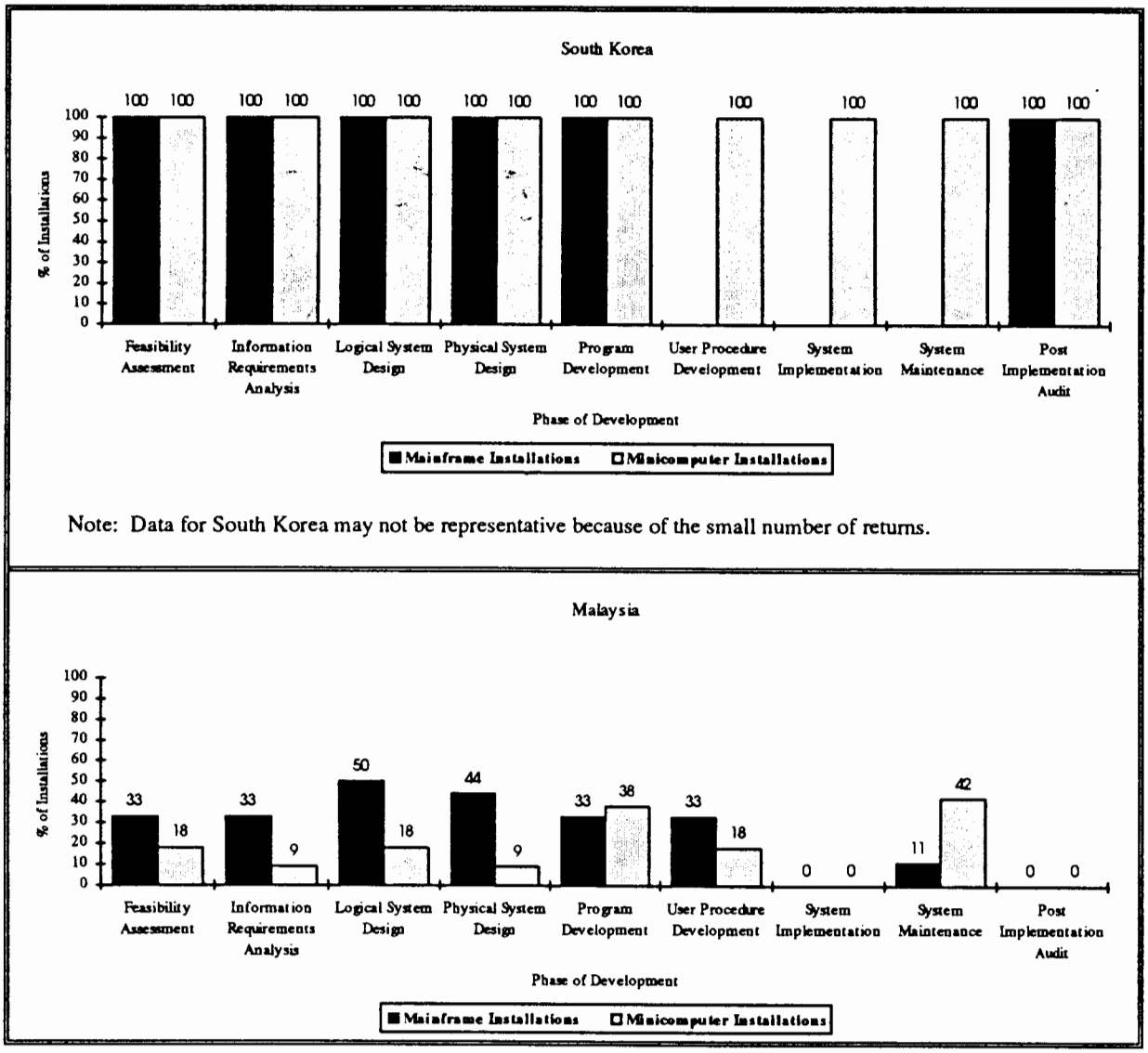


Figure 2 (Continued)
Use of Third Party Resources

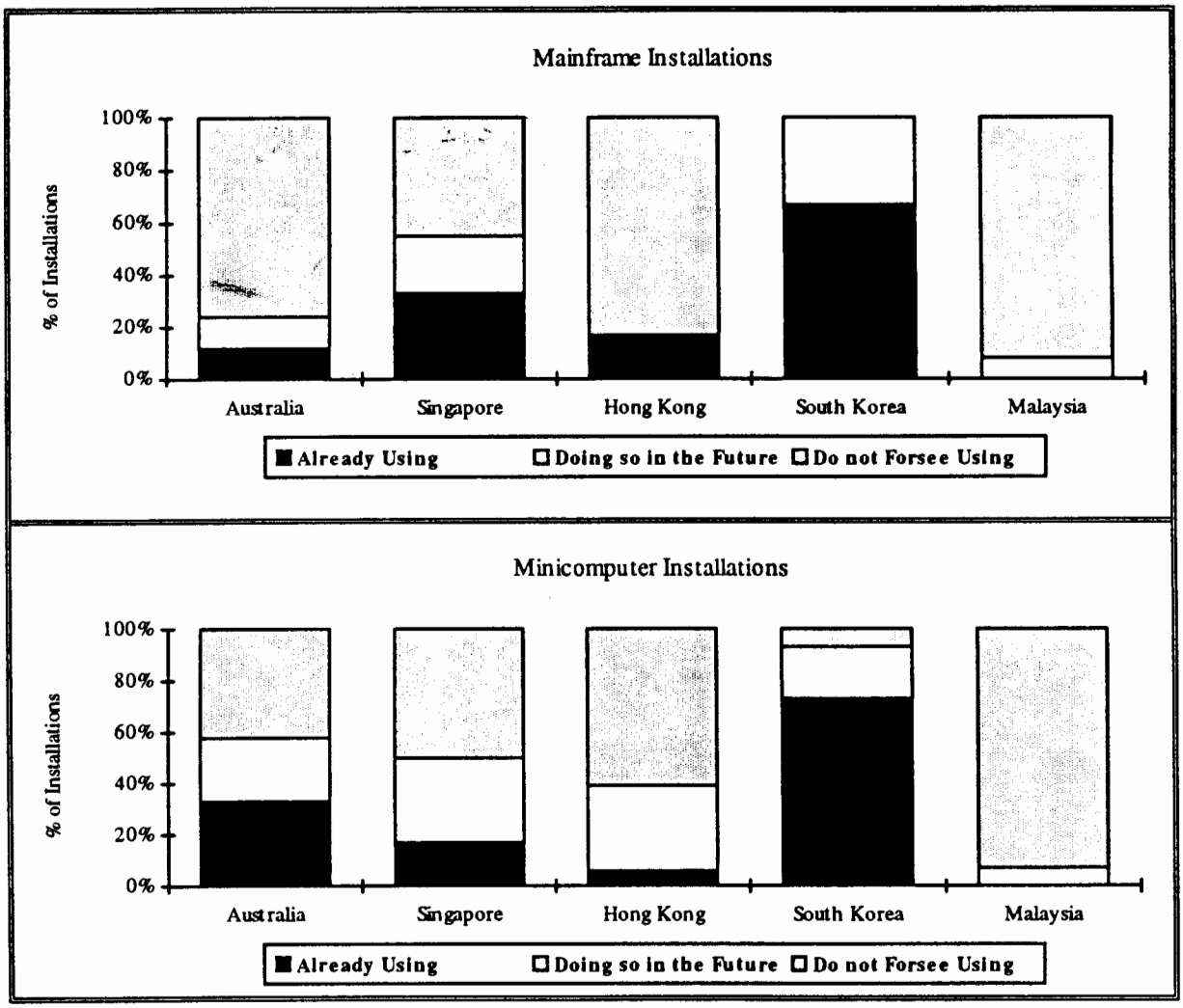


Note: Data for South Korea may not be representative because of the small number of returns.

which third-party resources are used in each phase of systems development. It shows a wide variation in the use of third-party resources across the five countries. About two-thirds of mainframe and minicomputer installations in Australia and Hong Kong make use of third-party resources in systems development. In Singapore, about one-third of the installations use third-party resources. In Malaysia, about one-third of mainframe installations use third-party resources; the use of third-party resources in minicomputer installations is less common, except for program development and systems maintenance. (Note: South Korea appears to be an outlier due to the small sample size.)

Outsourcing. Outsourcing means letting a third party manage all aspects of a computer installation for a fee. The third party is responsible for the development and running of applications and administration of the installation. The extent to which outsourcing is adopted in the five countries is shown in Figure 3. Three observations can be made from this figure. First, South Korea leads in outsourcing for both mainframe and minicomputer installations. Second, more minicomputer installations foresee using outsourcing in the future. Third, installations in Malaysia make very little use of outsourcing at present and less than 10% foresee using it in the future.

Figure 3
Outsourcing



Standards. Figure 4 shows the extent to which standards are used in the systems development process. For mainframe installations, standards are more widely used in Hong Kong, Singapore, and Australia. Standards are less commonly adopted in minicomputer installations, probably because the applications developed in these installations tend to be smaller in scale. The exception is Singapore where installations, whether mainframe or minicomputer, are expected to use the standards prescribed by the National Computer Board.

Software Development Productivity

Productivity of software development teams is an important concern in IT management. Figure 5 shows the percentage of installations that measure software development productivity. More than 50% of mainframe installations in Hong Kong and Singapore measure software productivity and the figure is much lower for the other countries. Measurement of software development productivity is less common in minicomputer installations, except in Malaysia where more minicomputer installations than mainframe installations measure productivity. None of the minicomputer installations in Australia and Singapore measure software development productivity.

IS Planning and Control

The IS plan of a computer installation is a blueprint to meet the IT needs of the client organization just as the

Figure 4
Use of Systems Development Standards

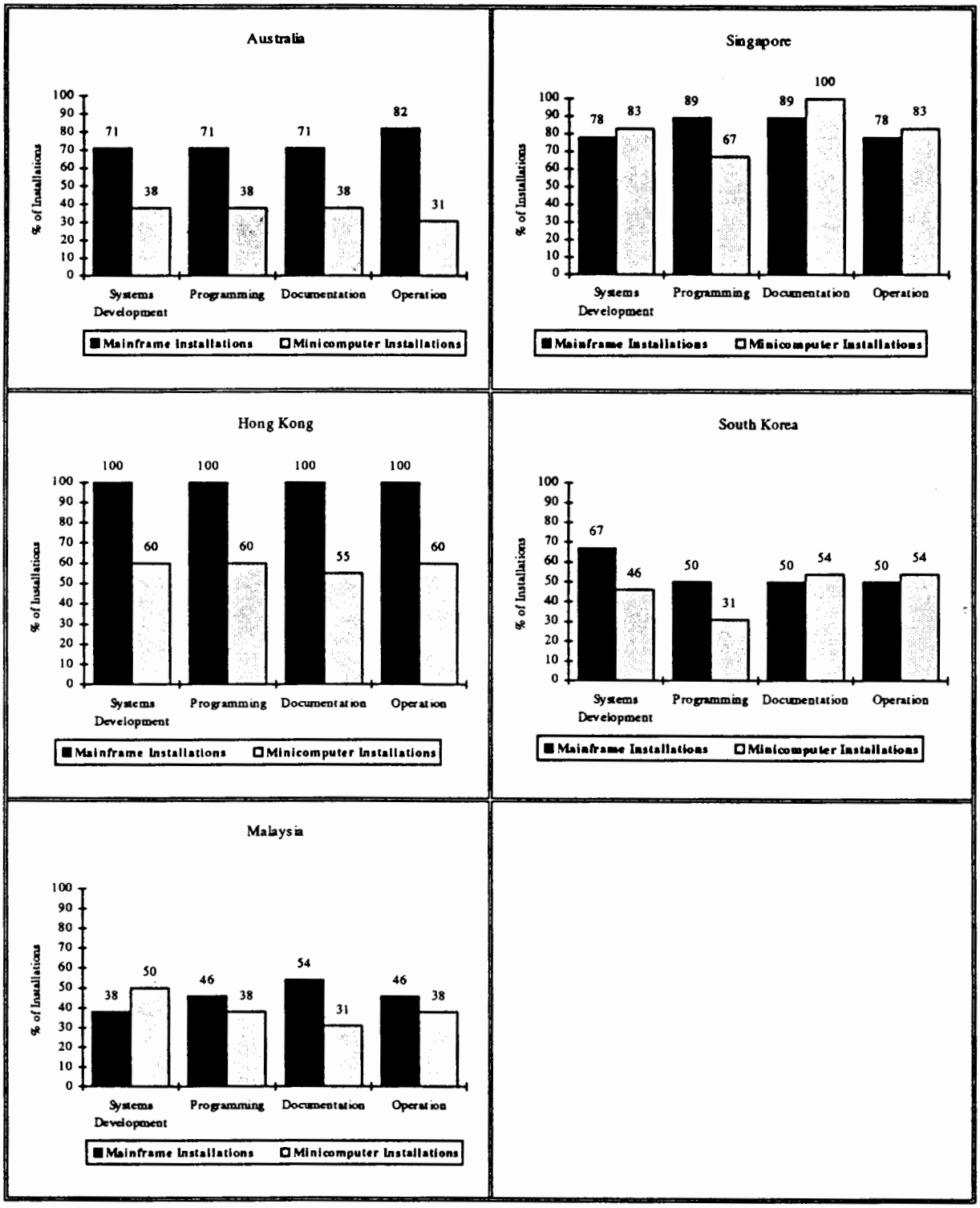


Figure 5
Software Development Productivity Measurement

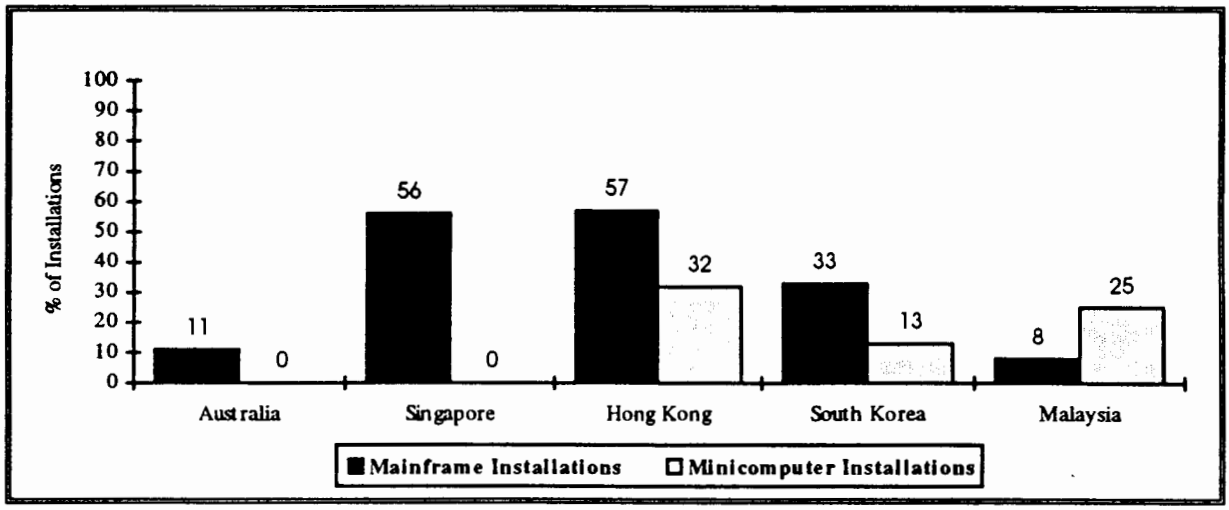
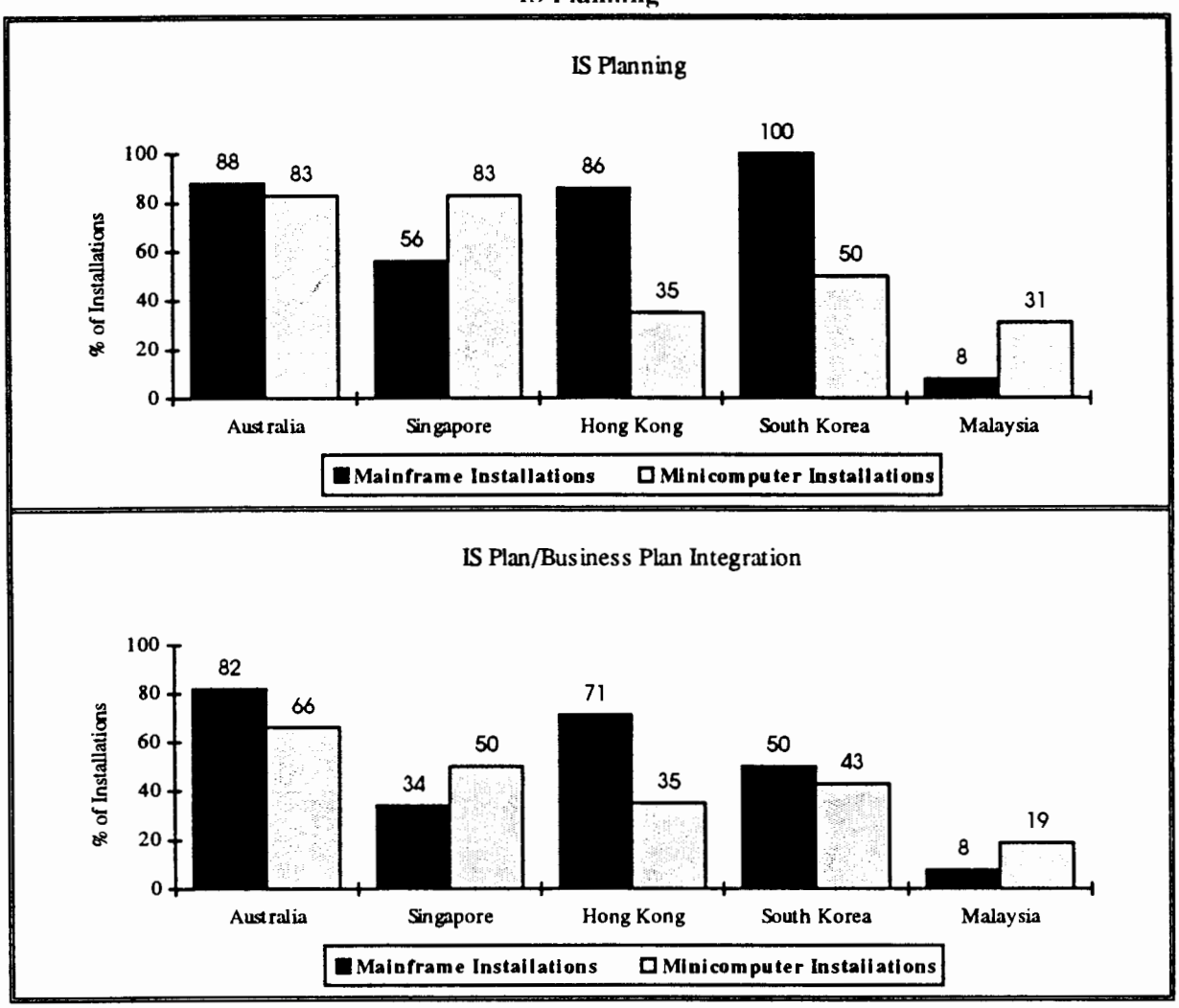


Figure 6
IS Planning

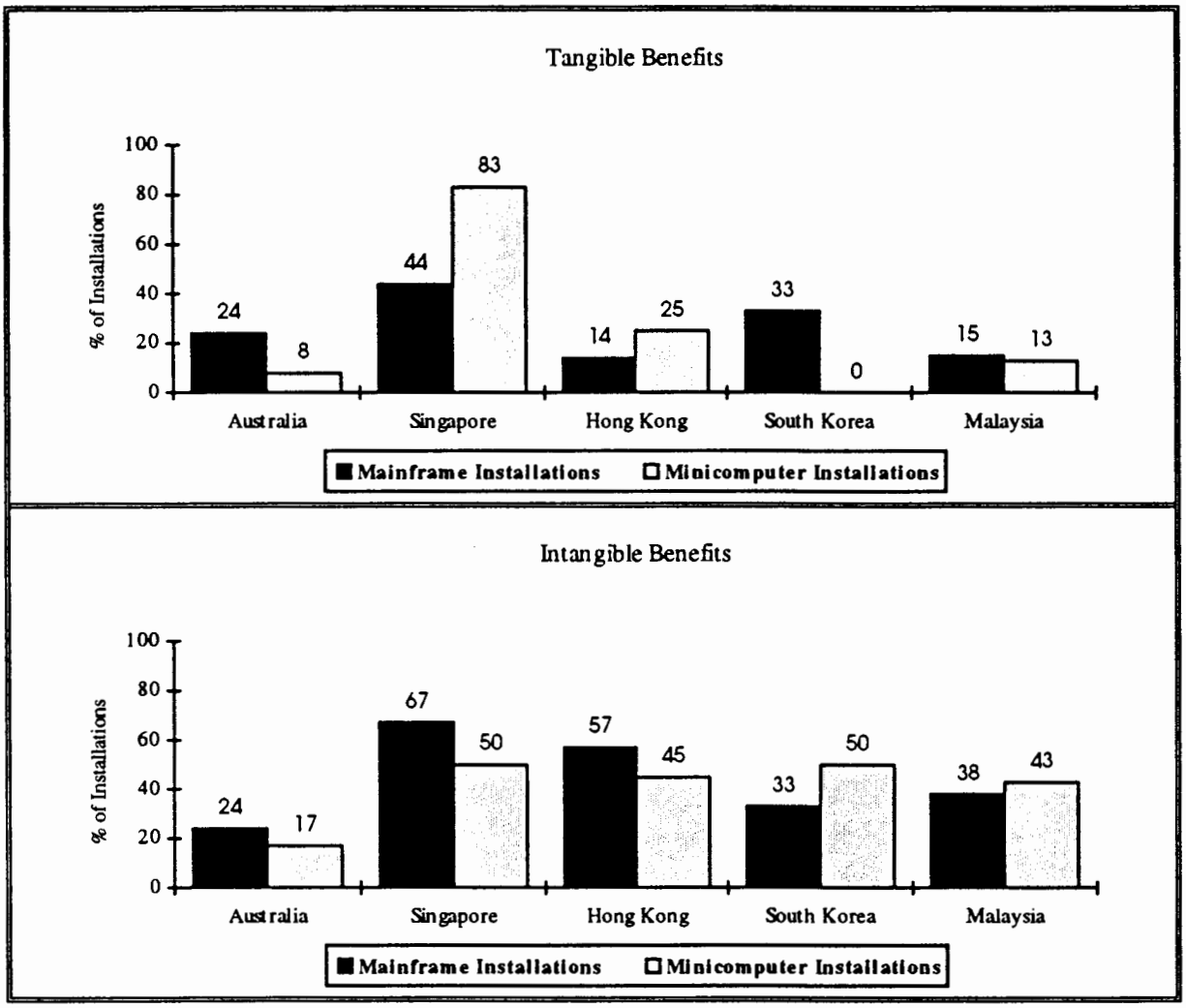


business plan is a blueprint for meeting the organizational objectives and goals. Increasingly, organizations integrate their IS plan and business plan to support corporate strategy. Related to IS planning is control, which typically measures the benefits of computerization efforts and provides feedback to improve IS planning.

IS Planning. Figure 6 shows the percentage of installations that have organization-wide IS plans for 3-5 year time horizons and the percentage of installations which integrate the IS plan and the business plan of the client organization. Mainframe installations in Australia and Hong Kong and minicomputer installations in Australia and Singapore emphasize IS planning and integration of their IS plan and business plan. IS planning is not widely practised in Malaysia, but those installations which do IS planning generally integrate their IS plans and business plans.

Measurement of Benefits. As part of management control, many computer installations measure the benefits, which can be tangible or intangible, of computerization. Figure 7 shows the percentage of computer installations in each country which measure tangible and intangible benefits. Singapore is most concerned about both the tangible and intangible benefits of computerization. This could be attributed to the stringent management controls introduced by the government and the close monitoring of IT investments and benefits by the Na-

Figure 7
Measurement of Benefits



tional Computer Board [7]. In the other countries, only about one-quarter of the installations track tangible benefits. It is interesting to note that installations in Australia, which rank high in IS planning and integration of IS plans and business plans, do not seem to stress measurement of benefits. Overall, more installations keep track of intangible benefits than tangible benefits. This could be due to the difficulty of quantifying benefits of computerization, particularly in government agencies where the objective of com-puterization is to improve delivery of services to the public.

CONCLUDING REMARKS

Several observations can be made on the findings presented above. Despite the limited sample size, it is clear that the responding computer installations in the five countries studied have achieved a high level of performance in several dimensions of IT management practice. These dimensions include file back-up practices, helpfulness of staff, usefulness of applications, utilization of equipment capacity, planning for future growth, and overall quality of service. In particular, installations in the more developed countries tend to make better use of available computing resources, emphasize IS planning and integration of the IS plan and business plan, and make greater use of standards in systems development.

These findings also identify two areas of concern, namely, training of users and disaster recovery capability. Across the five countries, user training seems to be a neglected area. User training deserves greater management attention because successful organizational assimilation of IT requires a transfer of "ownership" to the users. A basic understanding of the strengths and limitations of the technology and the system is essential for users to accept the responsibility of ownership. This understanding can be imparted by training. The findings also show that the responding computer installations do not rate themselves highly on disaster recovery capability. This is a cause for concern because government agencies increasingly rely on computer systems as a source of information and for delivery of services to the public.

Several areas for further research can be identified and three areas are discussed here. First, the use of outsourcing varies widely across the five countries and across the two technology platforms. Outsourcing is an administrative innovation driven by several organizational factors. It is also contingent upon the availability of external technical and human infrastructure to successfully take over the IT operations of the client organization. What are the organizational and external factors that motivate computer installations in government agencies to outsource their IT operations?

Second, in this study, the installations were asked to assess their own performance. While this self-assessment is useful to identify the internal strengths and weaknesses of the installations, it does not measure the extent to which the objective of improving service to the public has been met. This raises the question: who are the end-users in government computerization? It can be argued that in the case of IT in government there are two types of users: the civil servants who use the system and the public served by the civil service. Thus, for assessment of IT in government in the larger sense, it is necessary to study the perceptions of not only the civil servants, but also of the man-on-the-street.

The findings of this study show that IT management practices in computer installations vary across the countries. It would be interesting to characterize the factors which might influence IT management practices in central government agencies in these countries. Some of these factors could be client and IT organizational structure, existence of a central coordinating agency, level of funding and mechanism for approval and funding of projects, and the calibre of management and IT professionals.

Finally, it should be pointed out that IT management practices are dynamic because IT is a fast changing field. It is likely that the IT management practices reported in this paper have changed in response to changes in technology and environment. For example, Singapore has consolidated several computer installations into one large data center whose management practice may vary from those reported here. Nonetheless, the findings presented here are representative of the practices in 1990/91.

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