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CURRENT PRACTICES IN INFORMATION SYSTEMS DEVELOPMENT TOOLS AND TECHNIQUES

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ABSTRACT

The study examines the current practices in information systems development practices among Malaysian information systems managers and system analysts. Technical, organisational and intrinsic facets of information systems development process are assessed. Results indicated that most information systems departments are well-established within their organisations having a close link to top management and majority of the respondents have formal tertiary education in computer science or management information system. The study also indicates that 4GLs, data flow diagrams, data dictionaries and system flowcharts are the most familiar and widely used system development tools. CASE tools are used by all respondents especially for the analysis and design, implementation and project management activities. Majority of the respondents indicate that microcomputers are used extensively and most applications were developed using SQL and COBOL.

Keywords: ***Systems analysis and design, Systems development tools and techniques, CASE tools, Programming languages, Information systems practices.***

1.0 INTRODUCTION

Organisations have been using computers for over forty years to perform data processing tasks and generate information to assist decision making. The process of developing computer based information systems (IS) has changed significantly over the last twenty years. The steady and dramatic improvements in hardware technology in terms of improved capabilities and lower costs have heightened the need to improve the IS development process. Moreover, system analysis and design (SAD) of computer-based IS is a rapidly changing and one of the most creative and fulfilling fields in the IS discipline.

Many different tools, techniques and methodologies have been used to develop business IS [1, 2]. Various techniques and methodologies which have their own weaknesses as well as strengths have been created to aid the system development process. Early efforts followed the systems development life cycle and the traditional/classical approach. Within the last twenty years, the structured approach to SAD has emerged to address IS problems. The traditional and structured approaches have also been commonly combined with the systems development life cycle approach. Additionally, automated tools, prototyping and other techniques have been used to complement other approaches for developing business IS in organisations. General managers and IS managers agree that the delivery of effective IS is a key issue for the 1990s [3]. Which tools are being utilised and considered effective? Which tools enhance productivity and what are the techniques that are used to perform SAD? Are users satisfied with the available tools and techniques? What are the factors that influence the development process? These questions should be addressed if (1) the correct tools and techniques are to be selected in IS development, (2) the likelihood of success in effort is to be achieved, (3) computer specialists are to gain expertise in tools and techniques most valuable in achieving user satisfaction and career goals.

A review of the literature indicates that several studies have assessed the IS development process. Jones and Arnett [4] did a nationwide survey of the United State's highly experienced system analysts from the industry. Their findings indicated that while technical, organisational and intrinsic facets of the IS development process are changing, the changes are not occurring as rapidly as the literature often suggests. System flowcharts continue to be the most widely used tool. Relatively new products such as CASE tools are used by over one half of the analysts, yet their benefits are not being fully exploited. Carey and McLeod [5] reported that tool utilisation in the industry was lower than expected. They found that only 5 percent of the organisation utilised all 11 tools surveyed on a frequent basis. In addition, almost 16 percent of their organisations did not use any of the tools. The survey reported by Kievit and Martin [6] indicated much greater tool use and satisfaction compared to aforementioned two studies [5, 7]. Both data flow diagrams and system flow charts are the most popular design tools.

A study made by Necco et al. [8] implied that organisations are using a combination of techniques to develop their IS. Structured approach is the most popular one followed by automated aids and prototyping. However, the study did not focus on the tools that were used in the above techniques. Respondents from a study conducted by Sumner and Sitek [7] which focused on structured methods for SAD, acknowledged the benefit of using the tools but were not widely used. Two reasons were given: (1) lack of acceptance of the tool by data processing professionals, and (2) a perception that the tools were time consuming to use. Ein-Dor and Segev [9] reported that the likelihood of successful IS effort declines rapidly with the rank of the executive to whom the IS chief reports and is quite small if the executive responsible is more than two levels below the chief executive of the particular organisation which the IS serves. They suggest that an IS effort is more likely to be successful if the responsible executive is not identified with any specific functional area. Another organisational characteristic that may influence success of an IS is the age of the IS department. Franz and Robey [10] provided support for the proposition that a mature IS department produces better IS applications.

This study attempts to determine the current practices of IS development tools and techniques in Malaysian organisations. Specifically, this will covers IS managers and system analysts in the IS department and their knowledge, understanding and the use of the development techniques and the associated tools. The findings from this pioneering work are expected to bring benefits to database designers and practitioners, IS managers, system analysts and trainers as it provides some indication of the trend in adopting/practices of IS development tools and techniques. The results of the analysis may give some information to system developers, end users and computer specialists on the selection of tools and techniques appropriate to their needs.

2.0 METHODOLOGY

The survey questionnaires were sent to 686 IS managers and system analysts from 160 public and private organisations in Malaysia which have the IS department/unit listed in the Malaysian Directory. The IS managers and system analysts are experienced in medium and large-scale IS development efforts. 54 IS managers and 92 system analysts responded, yielding a 22 percent response rate. A two stage survey distribution was used, whereby the IS managers were asked to deliver the survey questionnaires to system analysts in the same department/unit.

The questionnaire was designed to measure the technical, organisational and intrinsic factors that affect the IS development process. For comparative purposes, all the tools and techniques were based on those used in [4] and [5]. The questionnaire also includes the automated approaches to system development such as CASE tools. Respondents were asked to describe the degree of familiarity and extent to which they used each of the tools and techniques. The degree of familiarity and extend of the use of the tools and techniques were rated in terms of a 6-point scale, starting from STRONGLY AGREE and moving down to STRONGLY DISAGREE. Other technical aspects that were addressed include the use of programming languages and type of hardware on which the IS was implemented. These were rated in terms of a 4-point scale, starting from EVERYTIME moving down to NEVER. The respondents were also asked to indicate the languages that they plan to use in the next five years. The questionnaire also addresses the organisational factors such as (1) number of years the IS department has existed, (2) position to which the IS managers report to and (3) number of levels between the IS department and the CEO/President of the organisation. The questionnaire also includes some intrinsic factors such as the educational level, educational background and experience level of both the IS mangers and system analysts. Educational level is defined as the highest degree obtained while educational background is defined as the primary field of study. The experience level of the IS managers and system analysts is defined as the number of years working in the IS area and the number of IS projects with which the subject has worked.

3.0 ANALYSIS OF THE RESULTS

The characteristics of IS managers, systems analysts and of the organisation are first addressed, followed by the practical application of systems analysis tools and techniques.

3.1 Information Systems Managers and Systems Analysts

Table 1 describes the profile of the IS managers and systems analysts. Approximately two-third of the IS managers surveyed in this study have been working in the IS area for more than 10 years and this is in agreement with the study done by Jones and Arnett [4]. Almost 56 percent have worked with no more than 10 projects. As to the educational level and background of the IS managers, almost one-half of the respondents indicated that their primary educational background is in computer science or MIS. Almost two-third of the managers are bachelors degree holders while only about a quarter of them are masters degree holders. This is in agreement with the study done by Jones and Arnett [4] and Shahrum et al. [11]. In the study by Shahrum et al. [11], about 69 percent of the IS managers hold degree in computing and related fields and about 61 percent are bachelors degree holders while 16 percent are masters degree holders. In the study conducted by Jones and Arnett [4], about 27 percent of the IS managers hold degree in computer science and MIS, 60 percent are bachelors degree holders and 7.1 percent are masters degree holders.

Table 1: IS manager and systems analysts: intrinsic factors

RESPONSE CATEGORY	**PERCENT OF RESPONDENTS**	
Educational Background	**IS Manager**	**Systems Analyst**
Information Systems (MIS)	21.65	13.33
Computer Science	31.96	54.82
Accounting	4.12	2.22
Operations Management	2.06	2.22
Engineering	6.19	2.22
Business Administration	9.28	4.48
Mathematics	12.37	13.33
Others	12.37	7.41
Educational Level		
High School /MCE	0.00	0.00
Pre-University/Matriculation/ 'A' Level/HSC	1.85	5.43
Diploma	11.11	16.30
Bachelors Degree	62.96	73.91
Masters Degree	24.07	4.35
Doctorate Degree	0.00	0.00
Experience Level		
Number of years in IS		
Less than 1	1.85	4.35
1 - 5	3.70	41.30
6 - 10	27.78	41.30
10 - 15	38.89	13.04
Over 15	27.78	0.00
Number of IS projects		
1 - 5	24.07	46.74
6 - 10	31.48	29.35
11 - 15	11.11	11.96
16 - 20	11.11	5.43
21 - 25	5.56	1.09
26 - 30	16.66	5.44

Of the systems analysts, about 54 percent have been working in the IS area for more than 6 years, yet about 76 percent have worked with 15 or fewer projects. However, the findings of Jones and Arnett [4] indicated a higher percentage (i.e. 97.2 percent) of the systems analysts have been in the IS field for more than 6 years. This may be due to the practice of hiring IS managers from outside the organisation and with managerial experience. Almost 47 percent have worked with 5 or fewer projects. As to educational background about 55 percent have qualifications in computer science and about 26 percent studied either MIS or mathematics. Almost three-quarter of the systems analysts are bachelor degree holders and about 16 percent are diploma holders. This is in fact the Malaysian job market scenario where only graduates are hired as systems analysts while diploma holders are hired as programmers and later promoted as systems analysts. More IS managers have masters degree than systems analysts, and fewer IS managers have only bachelors degree than do systems analysts. This is reasonable because there are two categories of IS managers. Some became IS managers because of their masters degree while others due to their bachelors degree and working experience. Majority of the systems analysts are from computer science background compared to IS managers while more IS managers are from MIS background compared to systems analysts. However, majority of the respondents are from computer science background compared to MIS.

3.2 Organisational Factors

The IS organisational factors are provided in Fig. 1 - 3. The IS departments/units in this study are well-established within their respective organisations (Fig. 1). Almost 45 percent have existed over 15 years. In addition, over one-half of the departments are independent of a functional area (Fig. 2). Finally, almost one-half are close to the top level of the organisation, being only one level removed from the CEO/President (Fig. 3).

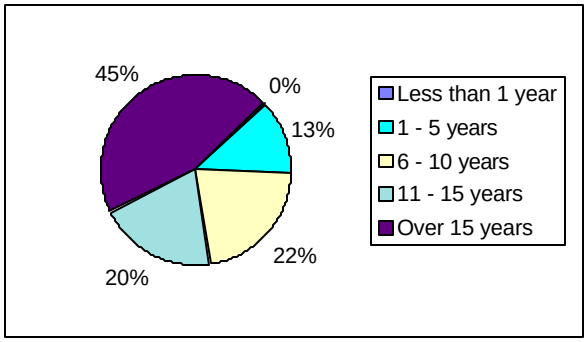

Fig. 1: Age of IS departments

The IS manager reports to either the CEO/President, an Executive Vice President or the Vice President of IS. For those departments that are part of a functional area, the most common is Finance/Accounting where almost 23 percent report to this area. In the survey done by Jones and Arnett [4], majority of the IS departments are well-established within their respective organisations. This is due to the fact that organisations in USA got involved in IS development earlier compared to the ones in Malaysia. In addition, the majority are close to the top level of the organisation, being only one level removed from the CEO/President and over one half of the departments are independent of a functional area. Their results also indicated that for those departments that are part of a functional area, the most common is Finance/Accounting where almost one-third report to this area.

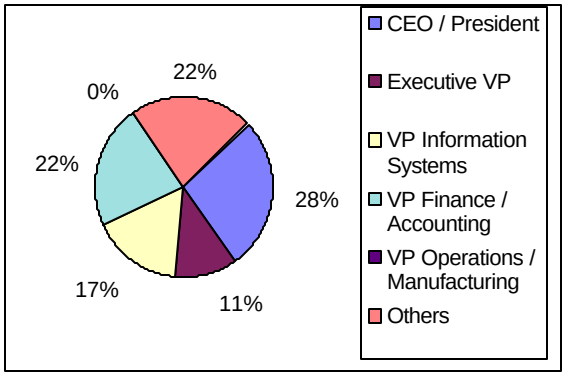

Fig. 2: Position to which IS manager reports

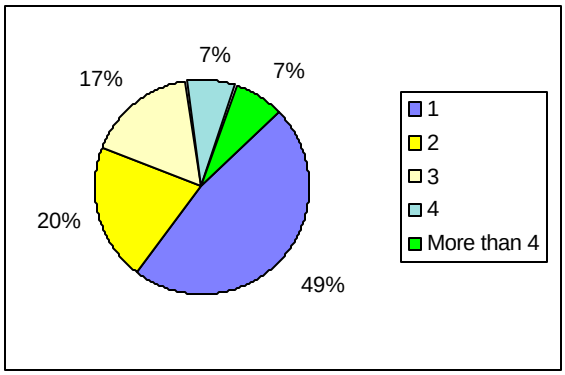

Fig. 3: No. of organisational levels IS manager is removed from CEO/President

3.3 Technical Factors

Technical factors assessed in this study include degree of familiarity and extend of usage with analysis, design and development tools and techniques, CASE tools type of hardware and languages for IS applications.

3.3.1 Information Systems Tools and Techniques

A profile of the tools and techniques with which the IS managers and systems analysts are familiar is provided in Table 2 while Table 3 depicts the tools and techniques used by the IS managers and systems analysts.

All respondents indicated that they are at least familiar with all the tools and techniques examined in this study. Tools which are most familiar are system flowcharts, 4GLs, data flow diagrams and data dictionaries while those are least familiar are Nassi-Shneiderman charts, tight English, Warnier-Orr diagrams and Yourdon diagrams. Among the techniques with which they are most familiar are prototyping followed by joint application development. The least familiar technique is found to be rapid application development. Over three quarter of the IS managers have the same level of familiarity with the above mentioned tools and techniques. This could be the reason for the adoption of these tools in the organisation. Familiarity does correspond with use. The results indicated that four most widely used tools are the most familiar tools while the two most widely used techniques are the most familiar techniques. It is also observed that the least use tools are the least familiar tools and the same applies to the development techniques. The extend of familiarity of the IS managers also correspond with usage.

The results on familiarity and use of IS development tools are in agreement with the studies conducted earlier [4, 5, 6]. The only difference exists on the number tools and techniques that are used in those studies. Jones and Arnett [4] did not include Nassi-Shneiderman charts while Carey and McLeod [5] omitted data dictionaries, 4GLs and tight English as tools listed in their surveys. Kievit and Martin [6] found system flowcharts, data flow diagrams and data dictionaries are the most widely used tools while the least used ones are Nassi-Shneiderman charts and Warnier-Orr diagrams. Their study did not include such tools as the 4GLs, tight English and Yourdon diagrams. However, the percentages of the use of system flowcharts are found to be slightly less compared to previous studies, maybe due to the fact that this is a recent study and graduates are exposed to newer tools rather than system flowcharts. According to Laudon and Laudon [12], the increase usage of 4GLs as software tools is due to the increase in demand of client server technology. This study indicates a high percentage of familiarity and usage of the prototyping technique in the IS application development and this is in line with the prediction made by Kievit and Martin [6].

Table 2: Extent of familiarity with analysis, design and development tools

	PERCENT OF RESPONDENTS					
TOOLS	**strongly agree**	**agree**	**slightly agree**	**slightly disagree**	**disagree**	**strongly disagree**
4GLs	35.62	48.63	6.16	2.05	0.68	6.85
Data Dictionaries	33.56	52.74	6.85	0.68	2.74	3.42
Data Flow Diagrams	34.93	46.58	12.33	0.68	2.05	3.42
Decision Tables	14.38	40.41	21.23	7.53	5.48	10.96
Decision Trees	8.90	40.41	21.23	6.85	5.48	17.12
HIPO Charts	4.79	19.18	24.66	11.64	10.27	29.45
Jackson Charts	1.37	13.70	28.08	10.96	10.27	35.62
Nassi-Shneiderman Charts	2.05	11.64	21.92	8.90	12.33	43.15
Pseudocode	15.75	31.51	24.66	9.59	3.42	15.07
Structure Charts	21.23	36.30	13.01	6.16	6.85	16.44
Structured English	12.33	29.45	21.92	9.59	6.85	19.86
System Flowcharts	35.62	48.63	6.85	2.74	0.00	6.16
Tight English	0.68	11.64	22.60	12.33	13.01	39.73
Warnier-Orr Diagrams	4.11	8.22	22.60	10.96	15.07	39.04
Yourdon Diagrams	6.16	15.07	23.97	8.90	9.59	36.30
TECHNIQUES						
Joint Application Development	32.88	38.36	10.96	0.68	4.11	13.01
Object Oriented Development	30.82	34.25	17.12	4.11	3.42	10.27
Prototyping	34.25	39.04	16.44	2.05	2.74	5.48
Rapid Application Development	20.55	33.56	19.86	5.48	4.79	15.75

Table 3: Extent of use with analysis, design and development tools

	PERCENT OF RESPONDENTS					
TOOLS	**strongly agree**	**agree**	**slightly agree**	**slightly disagree**	**disagree**	**strongly disagree**
4GLs	45.21	30.82	8.22	2.05	2.74	10.96
Data Dictionaries	33.56	45.21	8.90	1.37	3.42	7.53
Data Flow Diagrams	36.99	35.62	15.75	0.68	4.11	6.85
Decision Tables	12.33	32.88	19.86	6.85	8.22	19.86
Decision Trees	4.11	32.19	21.23	8.90	8.22	25.34
HIPO Charts	4.11	14.38	18.49	6.85	19.18	36.99
Jackson Charts	0.68	8.90	21.23	9.59	16.44	43.15
Nassi-Shneiderman Charts	1.37	8.90	15.07	8.90	19.86	45.89
Pseudocode	14.38	25.34	21.23	8.22	6.85	23.97
Structure Charts	19.18	27.40	18.49	4.11	9.59	21.23
Structured English	13.70	21.23	17.81	6.16	10.96	30.14
System Flowcharts	32.19	41.78	13.01	1.37	0.00	11.64
Tight English	2.74	10.27	16.44	15.07	13.70	41.78
Warnier-Orr Diagrams	2.74	8.90	14.38	11.64	15.75	46.58
Yourdon Diagrams	4.79	15.07	13.70	10.96	12.33	43.15
TECHNIQUES						
Joint Application Development	32.19	34.25	8.22	1.37	6.16	17.81
Object Oriented Development	26.03	29.45	19.86	2.05	7.53	15.07
Prototyping	34.25	33.56	18.49	2.05	2.74	8.90
Rapid Application Development	17.12	28.77	21.23	6.16	4.79	21.92

Table 4: Usage rating of CASE tools in supporting IS development activities

ACTIVITY	USAGE RATING (%)
Analysis/Design	
Diagramming	74.66
Screen/Report Painters	74.66
Analysers	57.54
Documentation	76.71
Simulators	50.00
Specification Language	50.68
Systems Information Management	
Repository	60.27
Info Management System	65.07
Implementation	
Code Generation	66.44
Database /File Generation	73.97
Testing	73.29
Maintenance	
Reformatting	62.33
Restructuring	63.70
Program Analysis	67.81
Project Management	
Estimating	70.55
Scheduling	76.03
Task Assignment/Tracking	71.23
Methodology Enforcer	58.22

3.3.2 CASE Tools

All respondents indicated that they use CASE tools extensively in supporting various activities in IS application development (Table 4). Usage rates are computed by adding up the percentage of respondents indicating STRONGLY AGREE, AGREE and SLIGHTLY AGREE. More than 70 percent usage goes to diagramming, screen/report painters, documentation, database and file generation, testing estimating, scheduling and task assignment/tracking. The major activities supported by CASE tools seems to be analysis and design, implementation and project management.

3.3.3 Hardware and Languages

Fig. 4 depicts the types of hardware used in IS application development. Majority of the respondents indicated that microcomputers are used extensively followed by minicomputers and mainframes. Interestingly, Jones and Arnett [4] found out that mainframes were extensively used in USA. However, a similar study by Shahrum et al. [11] expresses that the emerging skill requirements by the year 2000 in Malaysia will be the ability to build systems on PC followed by minicomputers. This indication maybe due to the high usage of PC in Malaysian IS organisations.

Table 5 shows that most applications were developed using SQL and COBOL followed by Dbase, C and C++. The least used language is Prolog maybe because of very few applications that have been developed using artificial intelligence concept. Ingres is another least used language. This finding also conforms to the finding of Shahrum et al [11] where IS applications development largely used SQL and COBOL. This could be due to the fact that most CASE tools generate COBOL codes.

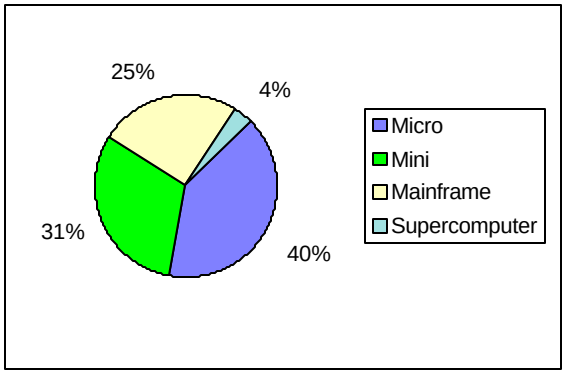

Fig. 4: Types of hardware most regularly used in IS application development

Table 5: Languages used in IS application development

Language Used	Everytime	Regular	Seldom	Never
SQL	29.45	30.82	17.81	21.92
COBOL	26.03	27.40	21.92	24.66
DBASE	3.42	30.82	30.14	35.62
C	6.85	17.12	26.03	50.00
C++	4.79	19.18	18.49	57.53
RPG	13.70	5.48	15.75	64.38
FOXPRO	6.16	13.01	15.75	65.07
PARADOX	4.11	9.59	14.38	71.91
INGRES	4.79	6.85	7.53	80.82
BASIC	3.42	7.53	27.40	61.64
PL/1	3.42	5.48	15.07	76.02
FORTRAN	0.00	6.85	17.12	6.85
PASCAL	1.37	4.11	19.86	74.65
PROLOG	0.00	0.68	8.90	90.41

Table 6: Other languages used

Languages use specified by 21.23% of respondents	Percent of respondents*
Visual BASIC	22.58
Natural	19.35
Informix	19.35
Assembler	12.90
Oracle	12.90
SQL	9.68
Easytrieve	9.68
Clarion	6.45
HTML	3.00
Revelation	3.00

* Categories are not mutually exclusive

Other languages used are profiled in Table 6. Commonly they choose languages such as Visual BASIC (23 percent) followed by Natural and Informix (19 percent each). IS managers and systems analysts were also asked to indicate which languages they expected to use in the next five years. 25 percent of the respondents indicated that they intend to use 4GLs such as SQL/SQLWindows followed by object oriented language such as C++ (24 percent) and COBOL (21 percent). Languages such as Pascal, PL/1 and FORTRAN are expected to be replaced by object oriented language such as C++. This finding is similar to the finding of Shahrum et al [11].

4.0 CONCLUSION AND RECOMMENDATION

Majority of IS managers and systems analysts have formal tertiary education in computer science or MIS. IS managers indicate longer experience in IS departments whereas systems analysts are involved in more IS projects. Most IS departments are well-established within their organisations having a close link to the top management. With these characteristics, majority of the IS managers and systems analysts are familiar with the usage of tools and techniques in developing IS applications.

This study also indicate that 4GLs, DFDs, data dictionaries and system flowcharts are the most familiar and widely used tools. The increased usage of 4GLs could be due to its simplicity and less development time requirement. A high usage of microcomputers and minicomputers is also indicated in this study and most applications are developed using SQL and COBOL. The future languages planned to be used by many are 4GLs and database languages. CASE tools are extensively used in supporting various activities in IS application development. Tools such as DFDs, data dictionaries and system flowcharts have high usage. This may be due to the extensive use of CASE tools especially in diagramming activity in analysis and design phase. This study also indicates that IS application developers need skills and training in 4GLs and CASE tools besides techniques such as joint application development, rapid application development and object oriented design. IS professionals need to be conversant in C++, COBOL and Visual BASIC.

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BIOGRAPHY

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