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A CMM Assessment of Information Systems Maturity Levels in Botswana

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ABSTRACT: *The maturity of information systems (IS) in corporate organizations has become crucial in influencing the maturity and effectiveness of other functional programs such as marketing, finance, production, and human resources. This study examines the maturity levels of IS in corporate organizations in a developing country, using the Capability Maturity Model (CMM). The results show that most parastatal and large organizations reside in the high echelon of IS maturity, while public and small organizations are still in the low levels of maturity. Majority of the organizations do not utilize the CMM software principally due to lack of knowledge of its existence. Furthermore, the study shows that the effectiveness and control of an organization's software processes and services improve as organizations move up the maturity levels.*

KEYWORDS: *Information Systems, Capability Maturity Model, Software, Key Process Areas, Software Process Improvement.*

1. Introduction

The information systems (IS) field is experiencing a tremendous rate of growth and divergence simultaneously. Our current information society is based on the premise that the use of electronic information will bring improvement in the quality of life of people. Information technologies (IT) pervade almost every aspect of daily life, necessitating constant assessment and evaluation of the impacts of technology on the society. Despite the popular association of information technology with business process improvement (BPI) and business process re-engineering (BPR), little research appears to have been done on how IT actually co-operates with business processes to improve their process capability (Hinks, 1998).

It is a fact that different types of information systems are developed for different purposes and the organizations differ in size and their information systems development capabilities; therefore there is no silver bullet universally true for any information systems development task. Progress has been made in developing participative approaches in which different stakeholders can raise issues related to the value that they attribute to information systems (Remenyi, White and Sherwood-Smith 1997). However, little has been said about the importance of understanding the context of relations in which

information systems are implemented and evaluated as an enabler or facilitator of change. Many organizations know that they need to improve their IT-related development processes in order to successfully manage change, but often don't know how. Such organizations typically either spend very little time/capital on process improvements because they are unsure of how best to proceed; or focus on a number of parallel and unfocussed efforts, to little or no avail.

The Software Capability Maturity Models (SW-CMMs) are able to address these problems by providing effective, proven practices and methods for organization's to gradually gain control over and improve their IT-related development processes. SW-CMM is basically a framework that describes the key elements of an effective software process. They provide a conceptual structure for improving the management and development of information systems products in a disciplined and consistent way. CMMs describe an evolutionary improvement path from an ad hoc, immature process to mature disciplined process (Olson, Reizer and Oyer, 1994). The various practices are typically organized into five levels, each level representing an increased ability to control and manage the development environment. An evaluation of the organization's practices against the model -- called an assessment -- determines the level at which the organization's information systems currently stands. It indicates the organization's maturity in the area concerned, and the practices on which the organization needs to focus on in order to realize the greatest improvement and the highest return on investment. The benefits of capability maturity models are well documented for software engineering. Their application to enterprise architecture has been a recent development, stimulated by the increasing interest in enterprise architecture in recent years, combined with the lack of maturity in this discipline. In assessing IS, participation and involvement of stakeholders has become an interesting if not essential feature of formative approaches to evaluation (Doherty and McAulay, 2001). The CMM model has gained a wide-scale acceptance over the last decade in supporting process improvement. Some of the current business drivers that continue to influence the development of information systems include: globalization of the economy, electronic-commerce, security and privacy issues, collaboration and partnership, knowledge asset management, continuous improvement and total quality management, as well as business process redesign (Muhammad, 2006).

The CMM was originally formulated as a tool to evaluate the ability of government contractors to perform a contracted software project. Though it comes from the area of software development, it has been, and it continues to be widely applied as a general model of the maturity of processes. Currently, the CMM is used for evaluating IS quality and maturity in both public and private organizations, large and small organizations, organizations especially in developed countries. The aim of this study is to discover the maturity levels of information systems of organizations in Botswana, be it a small or large

corporation, private or government organization. Botswana is a developing country that has a high level of technological advancement and global competitiveness [rated 8th in Africa] (Blanke, 2007). An attempt is made to assess the maturity levels through the Capability Maturity Model, which acts as a guide or framework for software process improvement. The study addresses the key process areas (KPAs) defined by the SW-CMM to evaluate the IS maturity levels of organizations. These KPAs address the organizations' IS planning, system quality, information quality, user awareness, IS performance evaluation, and organizational impact of IS. In specific terms, the study attempts to: (1) determine the level of utilization of the CMM by organizations in Botswana for process improvement; (2) determine if effectiveness, and control of an organization's software processes improve as the organization moves up these five levels of the CMM; (3) compare the maturity levels in terms of size and nature of organization.

2. Background

Information technology (IT) had been one of the fastest growing industrial sectors in developed countries in the last four decades. Through declining hardware costs and increasing benefits, IT has achieved varying intensities of diffusion in less-developed countries, many of which have joined the race to become "information rich" (Sackman, 1981). Being aware that computers are the most important factor in this process, some countries have developed or adopted robust information policies to realize their goals. Botswana is one those countries that have incorporated IT growth into its national strategy, named Vision 2016 (BV2016C [Botswana Vision 2016 Council], 2004), and aims to propel its socio-economic and political development into a competitive, winning and prosperous nation. In one of the seven key goals towards achieving this strategy, Botswana will be abreast of other nations in information technology and will become a regional powerhouse in the field (WITF [World Information Technology Forum], 2005). It further indicates that most people will be computer literate as most schools and workplaces will be equipped with computers. This enables Botswana to become an informed nation in which a culture of transparency and accountability will flourish. However, as a latecomer to the IT scene like most developing countries, it will face enormous difficulties such as becoming users of IT without the required infrastructure and manpower to support it.

The diffusion rate of IT in Botswana is currently relatively low. Internet subscription rates are less than 1% of the population with Internet access charges being relatively high in Botswana compared to most other South African Development Corporation (SADC) countries (Heeks, 2001). Currently, IT resources are limited and affordable to those fortunate to have access to them or extremely rich, thus creating what is nowadays called the "digital divide" (Venson, 2005). The effect of this digital divide is that those

without access to technology are likely to remain poor and isolated from developments nationally and internationally. The Internet in Botswana, for example, is accessed in three major locations: the Internet Cafes, schools and universities, businesses and research institutions (Mutula, 2004). In 1996, while most organizations in Botswana were aware of the Internet, few actually had access to IT and those that did made long-distance phone calls to Internet Service Providers in South Africa. At that time there was confusion about when the Internet would be readily available in Botswana. Today, it is said that most of the Internet market is fully liberalized, and that most of the users are currently corporate institutions and government organizations. Most organizations in Botswana have gradually resorted to the use of information systems in their daily processing of information and the provision of their services. Botswana ranks fourth after Mauritius, South Africa and Namibia in IT infrastructure development within SADC region (Mutula, 2004).

E-readiness is fundamental to the adoption of information systems especially in a networked global economy. It represents the capability of nations to create, diffuse, adopt and use various components of the networked economy. The rankings of e-readiness survey have become an established benchmark for countries seeking to harness the information system's potential to drive business efficiency, improve the provision of public services and encourage the integration of local economies with the global economy (Lane et al., 2004). The e-readiness rankings for 2006 shows that European countries took six of the ten top spots and Nordics occupy three of the spots with Denmark in the first position. According to McKenna (2006), virtually all countries included in the 2006 rankings improved their scores over the 2005 figures, with the improvements being more significant at the lower tiers of the ranking (consisting of developing nations) than at the top (developed nations). This implies that the digital divide is fast narrowing. Irrespective of the reduction in the digital gap, it is noted in Mutula and Brakel (2006) that e-readiness in developing countries especially in Africa is low when compared with those of developed nations.

Historical stimulus for growth of IT in Botswana has been a combination of curiosity and research as most access originated primarily in learning institutions. Current stimulus for IT growth and diffusion is the desire to become a contributing member to the regional and global communities as well as to further develop Botswana as an information society. Some internet cafe's in Gaborone report an average of 150 customers a day. Some potential reasons for this low usage include: low penetration of electrical services in the home, high cost of internet connectivity, high cost of basic computing hardware and little local content creation. Most businesses use the Internet primarily for collaboration purposes, while government use of IT is particularly visible through the central government site (Sairosse and Mutula, 2004).

The challenges above were addressed at the World IT Forum (WITF, 2005), which was held in Botswana and addressed the challenges of IT usage. The Government of Botswana has also introduced a draft national Information Communication Technology (ICT) policy, as well as a number of initiatives. Its e-government initiative will bring services closer to the people, and hopefully also act as a catalyst for the public as well as the private sectors to embrace IT and ICT. In addition, efforts are being made to reduce communication costs in Botswana, mainly through further liberalization of the telecommunications industry. This should create more competition and ultimately result in lower tariffs for consumers.

3. Research foundation

Information systems have become very important in the functioning of corporate organizations through the support for business processes, management decision making and strategic advantage (O'Brien and Marakas, 2007). Ultimately, information system has changed role from being a tool to being a driver of other functional areas in corporate organizations. However, there is a high level of concern regarding the quality of information systems (especially software components) utilized by corporate organizations (Ahern, Clouse and Turner, 2001). Smith (2004) observes that almost 70% of software projects are not completed, majority exceed budget estimates while running short on meeting requirements specifications.

In 1984, the Software Engineering Institute (SEI) led by Humphrey Watts began to work on a development framework that could address the problems stated above from the software developers' point of view (Humphrey, 1988). The result was the Capability Maturity Model (CMM). The CMM assists organizations in improving the quality of their software development and implementation processes towards "maturity"; that is, developing processes that have high predictability of results and low risk of encountering unknown variables or situations (Smith, 2004). The CMM development has been enhanced by lots of academic research in the field of process engineering. These research activities have led to the constant improvement of the CMM by SEI, and the creation of maturity models for different information systems components such as software acquisition (Kind and Ferguson, 1997), network development (Capone et al., 1998), system security management (Murine and Carpenter, 1984; Stacey, 1996), and project management (Fincher and Ginger, 1997; Hartman and Skulmoski, 1998; Remy, 1997). All these models were founded on the underlying principles of the CMM. The existence of several models caused organizations to incur additional training costs in inter-model transitions, and also created confusion on the part of practitioners regarding the model of choice. The SEI subsequently developed the "Integrated CMM" (CMMI) to eliminate

the conflicts by codifying the tenets of model-based process improvement engineering practices in organizations that span several disciplines (Ahern, Clouse and Turner, 2001).

3.1 Basics of capability maturity model

The Capability Maturity Model is a representation of a "common sense engineering" approach to software process improvement. The maturity levels, key process areas, common features, and key practices have been extensively discussed and reviewed within the software community with a consensus regarding software development and process improvement efforts. The CMM provides a conceptual structure for improving the management and development of information systems products in a disciplined and consistent way. The model characterizes the maturity of the organizations processes or information systems to establish the "as is" system; that is the current conditions and operations of the existing system specification. It then establishes goals for process improvements to define the "to be" system, which is the expected outcome of the system after its development/maturity phase. It then sets priorities for immediate actions as a process of transition from the "as is" to "to be" system. Stability then becomes effective through the management and sustainability of organizational changes. Changes in software process and components are then incrementally introduced to avoid the disruption of current systems. When an organization moves up these steps, it also moves up the maturity levels defined by the model.

In evaluating an information system component using the CMM, the following are considered (Wikipedia, n.d.; Figure 1):

1. Maturity Levels: A five layered framework that provides a progression to the discipline needed to engage in continuous improvement. The uppermost level (level 5) is the notional ideal state, where processes are managed by a systematic combination of processes optimization and process improvement.

2. Key Process Areas (KPAs): A key process area identifies a cluster of related activities, which when collectively performed, achieve a set of goals that are deemed to be important. The KPAs represent the stages that the organization must go through on the way to becoming mature, as each KPA identifies an organization goals, commitment, stability, measurements and verification.

3. Goals: The goals of a KPA provide a summary of the states that must be attained for that KPA to have been implemented in an effective and lasting manner. They signify the boundary, scope and intent of a KPA, and indicate how much of capability the organization has attained at a given maturity level.

4. Common Features: These include practices that assist in the implementation and institutionalization of a KPA. The common features include: commitment to

perform, ability to perform, activities performed, measurement and analysis, and implementation verification.

5. Key Practices: These describe the elements of infrastructure and practice that provides the most contribution to performance and institutionalization of the KPAs.

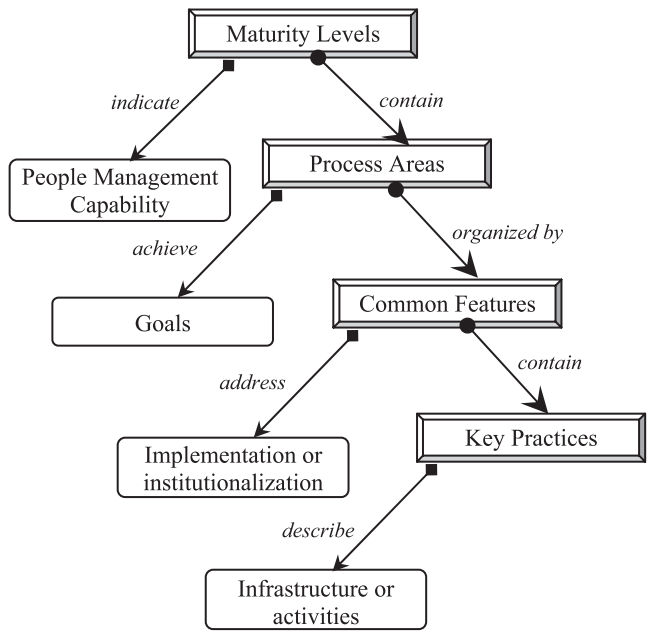

Figure 1 CMM Components

The five maturity levels of the CMM and their KPAs are explained below (Paulk et al., 1993):

3.2 Level 1: Initial

This is the base level whereby application development practices and results are inconsistent. Development processes are not properly defined and developers perform their assignments through individualized methods that show little consistency across the information systems of an organization. Project management is weak and protect developers are susceptible to disruption created by unreasonable commitments or excessive requirements changes. The Level 1 IS organization lacks the ability to consistently meet commitments. With no Key Process Areas prescribed for it, an organization is said to reside in level 1 maturity if its IS has been evaluated not to have achieved the KPAs mentioned below for the rest of the four levels of maturity.

3.3 Level 2: Repeatable

Level 2 focuses on requirements management, which is developing the capabilities of project managers to plan achievable commitments and establish control of requirement baselines and product configurations. Project management principles are established to track project costs, schedules and functionality, and applications are delivered on schedule. Although projects may use different methods or practices, the environment must be stabilized to support their performance. A concerted effort is made to repeat earlier project successes though skill and experience of the project team are crucial in project success. Effective project management practices lay the foundation for standardized processes in the next level. The following KPAs characterize level 2 maturity: requirements management, project planning, software project tracking and oversight, quality assurance, and software configuration management.

3.4 Level 3: Defined

At this level, a standardized system development process or methodology is purchased or developed. This is after projects can repeat successful or best practices, which are identified from different projects. These procedures are then integrated into a common process and deployed across the organization. A strong organizational culture emerges at Level 3 based on a common process that covers all the important elements of the organization's information systems. All projects use a tailored version of the common process to develop and maintain IS, and the organization can begin comparing results, sharing lessons learned and transferring people more easily among projects. Each project results in consistent and high-quality documentation and deliverables, and it is much easier to achieve targets for cost, functionality and scheduling. The process is then stable, predictable and repeatable. The third level maturity includes the following KPAs: organization process focus, organization process definition, training program, integrated software and service management, software product engineering, inter-group coordination, and peer reviews.

3.5 Level 4: Quantitatively managed

Organizations residing in this level of maturity have established measurable goals and productivity yardsticks. Having established a common process, an organization can then develop statistical capability baselines that characterize the expected results from performing these procedures. The baselines provide a quantitative understanding of the capability of development processes and the causes of variation in their performance. By statistically managing performance of the development processes, an organization is able to predict and control project outcomes much earlier in the course of a project. Thus systems development problems such as cost overruns, scope creep and schedule delays are tackled more proactively. Quantitative management enhances greater empowerment of

project teams and increased predictability of project results. The process can be adjusted or 'crashed' when the need arises based on predictable and measurable impacts. Its KPAs are; quantitative process management and software quality management.

3.6 Level 5: Optimizing

At this level, the system development process is continually monitored and improved based on measures and data analysis established at level 4. At this level of maturity, the organization continuously evaluates the capability of its processes to identify areas requiring the greatest improvement. Continuous improvements can be achieved by evaluating the results of lessons learned, or they can be accomplished proactively by evaluating new development methods, processes or technologies for potential adoption. A Level 5 organization ultimately establishes a facility for supporting continuous change management as a crucial component of its overall development process.

Each process of a given level becomes the new foundation for more sophisticated processes at the next level. Consequently, as an IS organization achieves the next level of maturity, the culture moves one step further away from the initial state toward an environment of professionalism and continuous improvement. Thus it is very important to recognize that each level is a prerequisite for the next level. Seeking formal assessment and improvement under this model can be time consuming and expensive, but the rewards in the quality of the software product and predictability of quality in future products are very real. Some organizations are so preoccupied with market and daily demands that serious process improvement initiatives are ignored. Additionally, many smaller organizations rightly view the CMM as designed for large shops or organizations, thus they cannot see its direct value (Gainer, 1998). While the CMM is neither perfect nor comprehensive, it does represent a broad consensus of the information systems and software community and it is a useful tool for guiding improvement efforts, and it can be used to equally help small organizations improve their processes. The CMM framework is shown in Figure 2.

The model indicates that with the exception of level 1 all maturity levels contain KPAs. The result of an appraisal is a capability maturity level and the maturity levels indicate process capability as well as contain KPAs which are organized by common features to achieve goals which are generic and specific. The common features simply address implementation and institutionalization. They contain specific practices that describe infrastructure and activities such as organizational factors and business factors. Organizational factors (culture, size, structure) and business factors influence the specific practices of an organization. In turn, those specific practices of an organization help it to define specific goals focusing on line of business, current process capability, and technology support. The specific and generic goals help in achieving the necessary KPAs that result in higher maturity levels of an organization's IS.

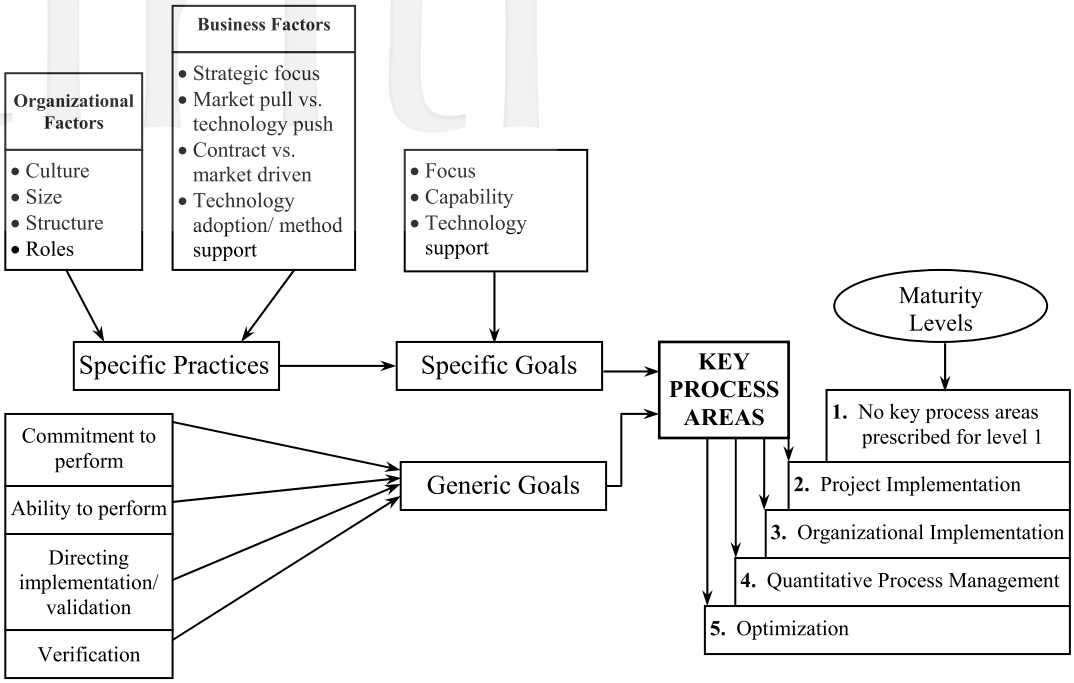

Figure 2 The Research Model

The following hypotheses were tested in this study:

H^1: Effectiveness and control of an organizations software processes and services improve as organizations move up the maturity levels.

H^2: Maturity Levels are not influenced by the nature of the organization.

H^3: There is a no significant correlation between size of an organization and its maturity level.

4. Research design

4.1 Survey procedure

The population of this research included both product and service providing organizations that were in the private, public or parastatal sectors of Botswana. Enterprises of different sizes were surveyed. The parastatal organizations are organizations that are partly owned and financed by government, but maintain some entrepreneurial independence. A total of 100 questionnaires were distributed to staff of fifty organizations, with an average of two questionnaires distributed to individuals who were either directly involved or aware of the information systems development and its impact on the organization. It is assumed that employees involved in IT/IS services

have a relatively greater understanding of the questionnaire and therefore provide useful information for the research, thus IT/IS specialists were the target respondents. A total of eighty-one people responded to the questionnaire (81%).

4.2 Measures

The data collection instrument used for this research was the questionnaire (Appendix), which consisted of three parts. The first part captures the sample characteristics such as respondents' job classification, age of organization, nature of organization, and size of organization. The second part of the questionnaire uses organizational variables relating to IS maturity to assess the maturity levels of an organization's IS. The variables used are known as Key Process Areas (KPAs), and they are defined for the Software Capability Maturity Model (SW-CMM). According to (Paulk et al., 1993) SW-CMM is a three-dimensional construct. The first construct is "Project Implementation", representing the maturity level 2 KPAs as; requirement management, software project planning, software project tracking & oversight, software quality assurance and software configuration management. Organizational Implementation is the second construct representing the maturity level 3 KPAs; organization process focus, organization process definition, training program, integrated software management, software product engineering, peer review, and inter-group coordination. The third construct is "Quantitative Process Management" representing the KPAs at both maturity level 4 and 5. At level 4, the KPAs are; quantitative process management and software quality management, while at maturity level 5 the KPAs are; problem prevention, process change management and technology change management. For an organization to achieve maturity in a particular maturity level it has to accomplish most of the KPAs in that maturity level as well as in the previous maturity levels. The third part of the questionnaire measures the use of the Capability Maturity Model (CMM) as a framework for process improvement and it minimally looks into different organizational reasons for the adoption of CMM. The data covers the following aspects: management of Information Systems, the efficiency and effectiveness of Information Systems and training programs.

4.3 Analysis procedure

The statistical analysis was carried out using Statistical Package for Social Sciences (SPSS) Version 14.0. The initial component of the analysis involves the use of descriptive statistics in capturing respondents and organization's characteristics, and the levels maturity of the organizations. Regression analysis was utilized in determining the factors influencing the levels of IS maturity. The hypothesis relating to the nature of organization and level of maturity was tested using the one factor analysis of variance (ANOVA). The ANOVA table provides a formal F test for the factor effect. The F-statistic is the mean square for the factor divided by the mean square for the error. This statistic follows an

F distribution with (k-1) and (N-k) degrees of freedom. The decision rule is to reject the null hypothesis if $F_{calculated} > F_{critical}$. Multiple regression analysis was further carried out in order to test the hypothesis that the effectiveness and control of an organization's software process improves as organizations move up the maturity levels. A correlation analysis was run to determine the relationship between organizational size and maturity levels.

5. Results and discussions

5.1 Sample characteristics

Table 1 shows the respondents' characteristics as well characteristics of the organizations they work in. There were a total of 81 respondents coming from private, parastatal and public organizations. A total of 29 respondents represented the Parastatal sector at a percentage of 35.8%; Majority (49.4%) were from the Private sector, while 14.8% represented the public sector. 82.8% of the parastatal organizations were 21 years and above, while only 10.3% were between 15 and 20 years, and 6.9% were between 5 to 10 years. 39.4% of the organizations were either small or medium sized, while the rest were large or very large. Majority of the large and very large organizations were parastatals, while majority of the small organizations were private. The respondents were from diverse industries, with the majority being general services-non-profit (27.2%), general services-for-profit (16.0%), and business/professional services (16.0%). Financial services occupied 13.6%, education 9.9%, wholesale and retail were 6.2%, while mining was 4.9%. The majority of the respondents were non-management staff and they constituted 82.8% of the parastatal sector, and 73% of the private sector and 58% of the public sector. On the other hand, 17.2% of the respondents from the parastatal organizations were management staff, as well as 28% of the private sector and 42% of the public sector respondents.

5.2 Determining maturity

The second section of the questionnaire addressed the key process areas of the CMM, which were used as the indicators for assessing the maturity levels in this research. Maturity Levels 2 through 5 can be characterized by three things: the activities performed by the organization to establish or improve the software process, activities performed on each project and the resulting process capability across projects. A behavioral characterization of Level 1 is included to establish a base of comparison for process improvements at higher maturity levels. Each maturity level has its own set of key process areas except for the Initial level. The following SW-CMM key process areas stated in Section 3.0 were used to help determine maturity levels.

Table 1 Sample Characteristics

	Nature Organization							
Size of Organization	**Parastatal**	**Valid%**	**Private**	**valid%**	**Public**	**valid%**	**Grand Total**	**Cumulative%**
Very Small	0	0	3	7.5	0	0	3	3.7
Small	0	0	10	25	3	25	13	16.0
Medium	5	17.2	8	20	6	50	19	23.4
Large	4	13.8	18	45	3	25	25	30.9
Very Large	20	69	1	2.5	0	0	21	26.0
Grand Total (%)	29 (38.5%)	100	40 (49.4%)	100	12 (14.8%)	100	81	100
Years in Operation								
<5 years	0	0	8	20	2	17	10	12.4
5-10 years	2	6.9	24	60	6	50	32	39.5
11-15 years	0	0	0	0	0	0	0	0.0
15-20 years	3	10.3	0	0	0	0	3	3.7
21 years and above	24	82.8	8	20	4	33	36	44.4
Grand Total	29	100	40	100	12	100	81	100
Industry of Organization								
Business/ Professional Services	2	6.9	11	28	0	0	13	16.0
Education	4	13.8	4	10	0	0	8	9.9
Financial Services	7	24.1	4	10	0	0	11	13.6
General Services-For Profit	1	3.44	12	30	0	0	13	16.0
General Services-Nonprofit	11	37.9	2	5	9	75	22	27.2
Health Care	0	0	2	5	3	25	5	6.2
Mining	4	13.8	0	0	0	0	4	4.9
Wholesale/ Retail	0	0	5	13	0	0	5	6.2
Grand Total	29	100	40	100	12	100	81	100
Respondents Position in Organization								
Management Staff	5	17.2	11	28	5	42	21	26.0
Non-Management Staff	24	82.8	29	73	7	58	60	74.0
Grand Total	29	100	40	100	12	100	81	100

80% of the data from the respondents for the KPAs were recorded on a 5 point scale, which were coded from 1 to 5, while the other 17% were recorded on a 4 point scale coded from 1 up to 4. 1 was the most significant option and 5 the least significant option, in all questions. This made it easy to integrate the data from each respondent, for each level of maturity and find their average. This average was then used to determine the maturity levels of the organizations from each respondent and then compared to the nature of the organization. It is important to understand that for an organization to reside in a particular level of maturity it must have accomplished or fully achieved all KPAs in that level and KPAs of the level below that one, if any. Thus, the averages of the total scale points were used to assess maturity level, also considering that some variables were satisfied by more than one option.

In relation to the 5 point scale, the following criteria were used to establish maturity levels from the averages of the key process areas.

(1-2.5): indicates that all KPAs were fully satisfied in that level and that the organization resides in that level and possibly more levels ahead of it, if any. But it must have also achieved all previous levels as well.

(2.5-3.5): indicates that the KPAs were partially achieved and that the organization resides in that level but not in any levels after that one. Also, it must have achieved all the other levels before it.

(3.5-5+): indicates that most of the KPAs were not achieved, therefore, the organization does not reside in that level nor can it reside in levels after that one. Instead, if it had achieved any level before that one then it will be said to be in such a level, otherwise it will reside in level 1.

Table 2 and Figure 3 show the distribution of maturity levels against the nature of organizations. This research shows that 49.4% of the organizations reside in level 5, and according to this table, 21 of them were the parastatal organizations, and 12 were private while 16 of them were public organizations. Level 1 organizations occupied 23.5% with the most being private organizations then public organizations. Level 2 organizations occupied 11.1% also by only private and public organizations. Level 3 was 8.6% from all types of organizations, as well as Level 4 with 7.4%.

While this study indicated that several organizations had gone up on the maturity grid, a sizable percentage of organizations were on levels 1 or 2 (33.6%). Majority of these organizations were private firms, which may not have elaborate/efficient information systems project management structure. Herbsleb et al. (1997) noted that planning and tracking of projects is an area that seems to be holding many level 1 organizations from achieving level 2. Active monitoring, staffing, and efficient resource allocation are management controls that appear critical in movement from the lower to upper levels of the maturity grid.

Table 2 Established Maturity Levels

	Nature of Organization				
Maturity Levels	**Parastatal**	**Private**	**Public**	**Grand Total**	**Percent**
Initial	0	13	6	19	23.5
Repeatable	0	8	1	9	11.1
Defined	4	2	1	7	8.6
Managed	4	1	1	6	7.4
Optimizing	21	16	3	40	49.4
Grand Total	29	40	12	81	100

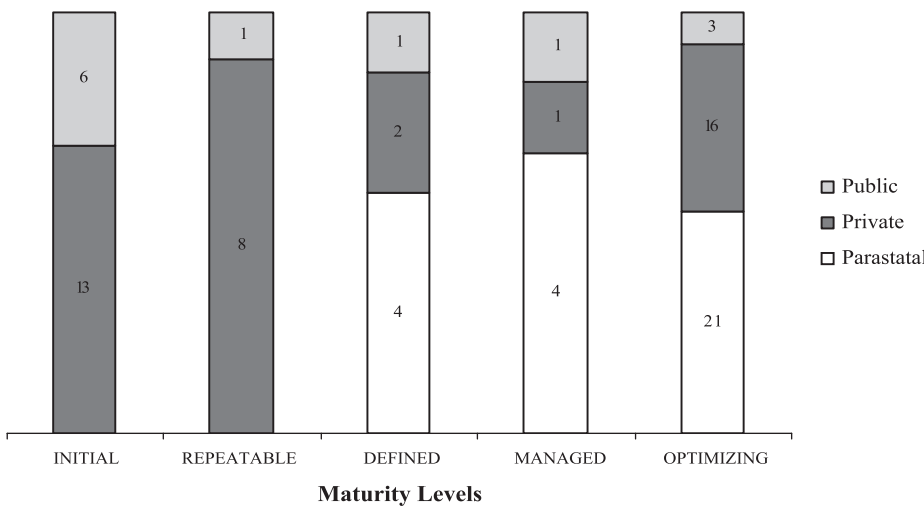

Figure 3 Maturity Levels and Nature of Organizations

5.3 Organizations' usage of the capability maturity model

The third section of the questionnaire focused on the adoption of the capability maturity model as a tool for process improvement. 100% of the respondents do not use the capability maturity model for process improvement. It was pertinent to find out the reasons why this model was not being used in Botswana. Table 3 shows that most people are unaware of the CMM. 81.4% of the respondents indicated lack of knowledge of the tool. Another factor most people strongly agreed to was that they had other preferences to invest in other ventures instead of purchasing the CMM (88.8%). Other factors are: high

purchase cost of the CMM, the risk of associated failure, and the lack of realization of benefits of the CMM to the organization.

Table 3 Factors influencing lack of use of the CMM

Factor	SA	A	N	D	SD	Total
Lack of Knowledge about CMM	50	16	5	8	2	81
Never seen CMM in use by other organizations	26	11	10	20	14	81
Preference to invest in other ventures	50	22	2	1	6	81
High purchase cost of the model	23	16	16	18	8	81
Associated failure	12	9	20	25	15	81
No realization of benefits of CMM	35	21	8	8	9	81

Note: SA = Strongly Agree, A = Agree, N = Neutral, D = Disagree, SD = Strongly Disagree

The results obtained with respect to non-utilization of CMM tools for software process improvement (SPI) are in consonance with previous findings (Staples et al., 2006) that identified the following reasons for organizations' inability to purchase CMM tools: small size of organization, lack of time for consideration of CMM software tools, utilization of alternative SPI approach, cost of implementing CMM, and a notion that CMM implementation was infeasible.

5.4 Hypothesis testing

The following hypotheses relating to the attainment of IS maturities were tested:

H[1]: Effectiveness and control of an organizations software processes and services improve as organizations move up the maturity levels

A statistical linear model was estimated in order to make inferences that can be made about the linear relationship that exists between the maturity levels and the improvement of the effectiveness and control of an organization's software process. The dependent (Y) variables are improvement of service, software improvement, and productivity improvement, generated from the section B of the questionnaire; while the independent variable (X) is maturity levels, which were established by key process areas. The purpose of this hypothesis was to determine if the independent variable (maturity levels) had an impact on the improvement of the dependent variables. Table 4 presents model summary, while Table 5 shows the results of the linear regression.

Table 4 Model Summary

Model	R	R Square	Adjusted R Square
1-Service improvement	.567	.322	.313
2-Software quality improvement	.737	.543	.537
3-Productivity improvement	.605	.366	.358

Table 5 Regression Statistics

	Unstandardized Coefficients		Standardized Coefficients	*t*	Sig.
Model	**B**	**Std. Error**	**Beta**		
1-Service improvement	-.130	.021	-.567	-6.123	.000
2-Software quality improvement	-.237	.024	-.737	-9.684	.000
3-Productivity improvement	-.151	.022	-.605	-6.750	.000

In all cases, $|t| \geq 2$, which implies that the level of maturity has a significant impact on service improvement, software quality improvement, and productivity improvement. Table 4 shows a better model fit (Adjusted R square = 0.537) for software quality improvement. Also, the t-values indicate that the software quality is mostly affected by the level of capability maturity ($t = -9.683$), followed by productivity improvement ($t = -6.750$) and service improvement ($t = -6.123$).

The results are consistent with previous results reported in (Herbsleb et al., 1997), which indicated that maturity level tends to affect quality, and productivity. It is also noted in Ravichandram and Lertwongsatien (2005) that variation in firm performance is explained by the extent to which IT processes support and enhance firm's core competences.

H^2: Maturity Levels are not influenced by the nature of the organization.

Table 6 utilizes an analysis of variance test to determine if the maturity level is significantly affected by the nature of the organization. The ANOVA table shows that F_{calc} (54.74) > F_{crit} (3.90). Therefore, the relationship between maturity levels and the nature of

organizations is statistically significant. With the p-value between groups less than alpha = 0.05, we say that there is a statistical relationship between the two variables, and the hypothesis is rejected. Therefore, the maturity level of an organization is influenced by the nature of an organization. Figure 2 indicates that higher maturity levels (level 4 and 5) were attained mostly by the parastatal organizations.

Table 6 ANOVA: Single Factor

Source of Variation	SS	Df	MS	F	P-value	F_{crit}
Between Groups	102.7222	1	102.7222	54.74463	7.32E-12	3.900236
Within Groups	300.2222	160	1.876389			
Total	402.9444	161				

Lee and Xia (2006) examined nature of organizations as a moderator influencing the relationship between size of organization and process innovation, and found nature of organization to be a significant moderator. Their results indicate that organization size may not be an advantage in process innovations for non-for-profit organizations. This study indicates that public organizations (non-for-profit) did not perform well on the maturity model. The parastatals on the other hand, occupy a significant amount in the *Optimizing* maturity level. The parastatals are made up of 82% large and very large organizations, which might add reason for the attainment of higher maturity levels. Most public organizations are at the initial levels of the CMM. This could be attributed to poor work attitude and *laissez faire* management style that is associated with public organizations (ROB, 2006) especially in Botswana with a good level of dissatisfaction among workers in public organizations. Recently, the government introduced scarcity and retention allowances (ranging from 15% to 40% of basic salary) for public service workers. The parastatals are considered private corporations that work under government regulations and financial support. It is noted that parastatals in Botswana were previously public organizations, and there is exodus of high skilled professionals from the public service to the parastatals. This may have warranted the introduction of retention allowances for public workers. Moving up the CMM levels by parastatals is not a surprise because these organizations tend to show world class standards by adopting the best management, service, and other organizational processes and practices.

H^3: There is a no significant Correlation between size of an organization and its maturity level.

Table 6 shows organization size against level of maturity. A correlation analysis was carried out between size of organization and maturity level. The results show a correlation of 0.669942, which is indicative of a good correlation between the size of the organization and maturity level. We accept the hypothesis that there is a significant correlation between size of an organization and its maturity level. Table 7 shows that 87.5% of the small and very small organizations reside in lower levels of maturity (level 1 and 2).

Table 7 Size of Organization Against Level of Maturity

Count of Size of Organization	**Size of Organization**					
Maturity Levels	**Very Small**	**Small**	**Medium**	**Large**	**Very Large**	**Grand Total**
1	3	8	7	1	0	19
2	0	3	4	2	0	9
3	0	0	1	4	2	7
4	0	0	1	3	2	6
5	0	2	6	15	17	40
Grand Total	3	13	19	25	21	81

According to the results, most maturity levels were found at level 5 (Optimizing). However, most small and medium sized enterprises (SMEs) have not yet fully established their IS departments in order to achieve the best in process development and delivery. The adoption of the CMM is relatively low in Botswana as most organizations fail to employ tools that help with process improvement and requirements. The study shows that service improvement, software quality and increasing productivity are being affected positively with upward movement on the CMM ladder. Though most of small and medium sized organizations do spend a lot on IT infrastructure, they lack good implementation strategies. Another factor was the poor work culture and negative attitudes, which tend to impact negatively upon the maturity of these organizations.

This study agrees with previous studies that established a positive relationship between firm size and IS maturity. McBride, Henderson-Sellers and Zowghi (2004) found a correlation between system maturity and organizational size in a study conducted in

Australia. In another study, Jung and Hunter (2001) found that the average capability level for organizations with large IT staff is greater than the capability level for organizations with small IT staff. Lee and Xia (2006) examined the relationship between organization size and IT process innovation. They concluded that though there is a positive correlation between organization size and process innovation, the following moderators affected the relationship: type of innovation, type of organization, stage of innovation adoption, and scope of size.

6. Conclusion and limitations

Information systems development is a complex process comprising not only technological expertise, and analytical and designing methodology, but also issues of process improvement and project management. It is the reality that different types of information systems are developed for different purposes and the organizations differ in size and their information systems development capabilities. Many people and generally organizations are unaware of the Capability Maturity Model and its potential benefits. Instead, they continue to spend a lot on Information Technologies without a strategy. This study shows that 77% of organizations spend highly on developing their IT services but some of them continue to remain in low levels according to the CMM assessment. The capability maturity model is rarely used in Botswana by all sectors and sizes of organizations. This research supports the assertion by Dillion (2001) that even if a technology is engineered to be highly usable, and shown to be so through formal testing, there exists no guarantee that this will lead to acceptance. Continuous process improvement is based on many small, evolutionary steps rather than revolutionary innovations. The staged structure of the CMM, which was used in this research is based on principles of product quality espoused by Shewart and Deming (1939). Organizations find the model costly, and would rather invest in other business ventures. Despite the non utilization of the CMM, many organizations had reached a high level of maturity. A significant 49.4% of the organizations have reached maturity level 5 and 7.4% are at maturity level 4. The results indicate that a total of 56.8% of organizations reside in the higher levels of maturity.

This research has shown that public organizations are lagging behind in information systems developments, indicated by the amount of public organizations that attained only lower levels of maturity. Some of the reasons for low maturity include low level of training and skills of workers, poor working conditions and incentives for staff members, poor documentation of software requirements and architecture, and the integration of software components. Low usage of the appropriate technology as well as poor management culture and negative attitudes are also factors that hinder full development

of information systems in the public sector. It is recommended that public sectors should concentrate more on process improvement; through assessing their current IS situation, and exposing themselves to more information systems innovations, which include process tracking, and documentation for efficiency and effectiveness.

It was also discovered that all sectors find it costly to manage information systems. A proper management system is therefore suggested. According to Barati and Berg (2003), a good management system is the key behind the success of many IS implementations. This also helps in purchasing technologies that are appropriate for the organizations.

While this study utilized the CMM constructs in assessing IS maturity of public, parastatal and private organizations in Botswana, it is pertinent to note that the CMM was utilized because of the belief that it captures the organization's IS program as an integral whole. Future studies could utilize the CMMI especially when considering the IS as consisting of several interrelated programs such as security, network management, project management, e-commerce, etc. Furthermore, the maturity of organizations across industries could be considered.

The Assessment Requirements for CMMI [ARC] (SEI, 2006) stipulate that the ratings of organizations' maturity level be performed by a qualified software evaluation professional. In this study, a sampling of software experts was done *apriori*. This stems from the fact that their levels of expertise in software process evaluation was assumed based on their job positions in the organizations. The self reporting data collection mechanism that utilized professionals from within the organization could create some level of bias that may have skewed the results towards higher maturity levels.

In this study, the dataset representing maturity levels 2-4 represent a small percentage of the survey (27.1%). This shows a significant kink in the expected gradient of maturity levels. Level 1 constituted 35%, while level 5 constituted 49.1% of the respondents. One explanation for this low number of respondents at the lower levels maturity could be that a high percentage of the organizations had passed through levels 2, 3, and 4 to level 5, while the other majority (level 1 and mainly small organizations) are not making efforts towards software process improvement. Another explanation could be in terms of the non-response bias of the survey. It is probable that a high percentage of non-respondents are from organizations that operate within maturity levels 2-4. Though the non response rate was statistically low (19%) according to Armstrong and Overton (1977) evaluations, it could affect the results of the survey.

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Appendix: Questionnaire

SECTION A. BACKGROUND QUESTION

1. Please give your company details.
Please tick the most appropriate option.

a) How do you classify your organization in terms of size?
Very Small ☐ Small ☐ Medium ☐ Large ☐ Very Large ☐

b) State the nature of your organization.
Private Organization ☐ Parastatal Organization ☐ Public Organisation ☐

c) Number of years your organization has been in operation.
< 5 years ☐ 5-10 years ☐ 11-15 years ☐ 15-20 years ☐ 21 years and over ☐

d) Which of the following best describes the industry of your organization?
Mining ☐ Manufacturing ☐ Education ☐ Business/Professional Services ☐
Financial Services ☐ Health Care ☐ Public Administration ☐
General Services-NonProfit ☐ Wholesale/ Retail ☐ General Services-For Profit ☐

e) How would you classify your position within the organization?
Management staff ☐ Non management staff ☐

SECTION B. KEY PROCESS AREAS FOR ACHIEVING CAPABILITY

2. Are you aware of any documented procedures within your work place that are meant to capture, refine, prioritize and track the development of customer requirements?
Yes ☐ No ☐ Unsure ☐ Not Applicable ☐

3. How do you feel about the management of Information Systems in your organizations?
Very Satisfactory ☐ Satisfactory ☐ Neutral ☐ Dissatisfactory ☐ Very Dissatisfactory

4. How effective do you think your organizations' Information Technologies and Information Services are, with regards to achieving customer satisfaction?
Very Effective ☐ Effective ☐ Neutral ☐ Ineffective ☐ Not at all ☐

5. Has your company's Information Systems delivery ever been evaluated against either the company's documented expected performance, or the level of expected performance within its industry?
Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

6. Has your organization established a website that people can access to gain information about it?
Yes ☐ No ☐ Unsure ☐ Not Applicable ☐

7. Do you often use email/ telephone to communicate with your customers?
Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

8. How easily accessible is email/Internet at your work place?
Excellent ☐ Good ☐ Average ☐ Poor ☐ Not Applicable ☐

9. Has the existence of email/internet in your work place enhanced the communication between yourself and other staff members?
Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

10. Do you think your organization has adopted all necessary technologies to help it achieve the following?

	SA	A	B	D	SD
Its business goals					
Achieve customer satisfaction					

11. Would you agree that your organization conducts regular activities that assess, develop and help to maintain the service delivery of your Information Systems?
Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

12. How often is information collected from within the organization about the efficiency of your Information Services / Information Technology delivery?
Never ☐ Once ☐ Occasionally ☐ Frequently ☐

13. Is there any standard or common Software /methodology being used within your organization in its daily service delivery activities, to help achieve its goals?
Yes ☐ No ☐ Unsure ☐

14. Please indicate by a tick if you agree or disagree to each of the following, where; SA= strongly agree, A= agree, N= neutral, D= disagree and SD= strongly disagree.

	SA	A	N	D	SD
The organizations standard software process is developed and maintained according to a documented procedure					
The organizations standard software process is documented according to established organization standards					
The organization has established and maintained a software process database					
The organization has documentation of all software related processes					

15. Please indicate the percentage you think, of staff that might have access to any if not all of your IT facilities. *Tick where appropriate*.

0	
Less than 20	
21-40	
41-60	
61-80	
81+	

16. Indicate the approximate percentage of those staff members that have rights/ privileges to using the common/standardized software that has been adopted by the organization.

0	
Less than 20	
21-40	
41-60	
61-80	
81+	

17. Does your organization offer any training programs to its staff members, on how to use the standardized software?

Never ☐ Once ☐ Occasionally ☐ Frequently ☐

18. Please indicate by a tick if you agree or disagree to each of the following, statements; SA= strongly agree, A= agree, N= neutral, D= disagree and SD= strongly disagree.

	SA	A	N	D	SD
Different departments are able to share processed data and lessons learned from different on going projects					
There is Maintained consistency in Information Service delivery					
The Software in use is in performance with relation to the organizational requirements					
The organization does Software testing (according to the Projects' defined Software Process)					
There is documentation of Software Engineering tasks, such as through Requirement documents and Test Plans					

19. Are there regular Technical Review interventions and Interchanges being conducted between the Information Services group and other departments/groups?

Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

20. How effective do you think the Information Systems team is, with addressing the Organizations System Requirements, objectives and issues?

Very Effective ☐ Effective ☐ Neutral ☐ Ineffective ☐ Not at all ☐

21. How often has your organization had external people to audit the implementation of its Information systems?

Never ☐ Once ☐ Occasionally ☐ Frequently ☐

22. To what extent has the use of Information Systems changed your organizations performance looking back at the past 5 years?

Extremely ☐ Moderately ☐ Slightly ☐ Has Not Changed at all ☐

23. What has this change brought to your organization?

Please rank each statement by significance, circling either the most significant number as 1, the second most significant 2…5 the least significant.

Improved productivity	1	2	3	4	5
Increased profits	1	2	3	4	5
Improved services	1	2	3	4	5
Improved Employee and customer relations	1	2	3	4	5
Increased performance against competitors	1	2	3	4	5
Offered uniqueness to the market	1	2	3	4	5
Reduced employee turnover	1	2	3	4	5

24. Where do you think the Costs of managing your Information Systems lies?
High ☐ Average ☐ Low ☐

25. How effective do you think your organizations Information Services department is in response to solving user problems?
Very Effective ☐ Effective ☐ Slightly Effective ☐ Ineffective ☐ Not at all ☐

26. How would you rate the type of technology in use within your organization?
Excellent ☐ Good ☐ Average ☐ Poor ☐ Not Applicable ☐

27. How effective do you think the injection of these technologies into the organization is?
Very Effective ☐ Effective ☐ Slightly Effective ☐ Ineffective ☐ Not at all ☐

28. How well is the response towards the use of these technologies by staff members?
Very positive ☐ Positive ☐ Neutral ☐ Negative ☐ Very Negative ☐

29. How would you assess the improvement of the following looking in the past year: *Tick where appropriate*.

	Improved	Remained Constant	Deteriorated
Service Improvement			
Software Quality			
Increasing Productivity			

30. To what extent would you assess the following factors to have contributed to the low improvement of the above: (*service delivery, software quality & productivity*) *(Tick appropriately.)*

Factors influencing service, software & productivity improvement

Factors	Very Much	Much	Not Much	Very Little	Not at all
Low Level of training and skill of workers					
Poor Working conditions and incentives					
Poor documentation of software requirements, architectures & integration of software components					
Low Usage of appropriate technology					
Low Management calibre					
Poor work culture and negative attitudes					
Poor Work method and work design					
Unmotivated workers					

SECTION C. THE USE OF CMM FOR PROCESS IMPROVEMENT

31. Does your organization use the Capability Maturity Model or any other model/ tool/ framework/program, for Process & Quality Improvement in their Information Systems?

Yes ☐ No ☐ Other (Specify) _____

32. If you answered Yes above or mentioned another model or tool please identify the reasons for using it. Where: SA= strongly agree, A= agree, N= neutral, D= disagree and SD= strongly disagree. *(You can select more than one option.)*

Reasons for adopting the CMM	SA	A	N	D	SD
Persuasion from various sources					
Perceived competitive advantage in the market					
From observing beneficial results by other organizations					
Government funding					
Perceived ease of use of the model					
Quality in Software development and implementation of processes					

33. If you answered No in part (a) above, please identify the reasons for using it. *(You can select more than one option.)*

Reasons for not adopting a model/ tool for Process Improvement	SA	A	N	D	SD
Lack of technical Knowledge about the tool					
From observing lack of use of the CMM by other organizations					
Preference to invest or upgrade other business ventures					
The high purchase cost of the model/tool					
The risk of associated failure					
Lack of realization of value/benefits of the CMM to the organization					