

Enhancing innovation in software development using business process excellence

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ABSTRACT

The aim of this study was to assess the impact that Business Process Excellence has on the innovation process to create new products and services in the software development environment. The best practices were identified in the current use of BPE in software development organisations. Subsequently, a proposal was put forward to enhance the use of BPE in the software development process to create innovative products and services. Once these products are implemented the organisation can use these products as a sustainable competitive advantage. The use of Business Process Excellence in software development creates an innovative environment for employees in order to develop innovative products that can create shareholder wealth, and increase market share. Companies want to create products that are unique to the market, and be able to offer their customers products that only they can offer in order to secure future business.

Innovation is a key factor to enhance processes within the software development company. Enhancing the processes can generate new ideas that contribute to the sustainable competitive advantage of the company. The literature does not create a definite link between the use of Business Process Excellence and innovation, and the study aimed at evaluating the possibility to merge the concepts.

Business Process Excellence optimises a currently implemented process, by exploring all ideas to increase the effectiveness of the system. It is a structured way to ensure that all possibilities are explored before a decision is made on how the process is structured to implement new products or services.

The software development industry is a very competitive industry, and most companies do not share their competitive strategy, or make it available to the public, to ensure that they would be offering their customer something unique. These companies would only make their strategy known to the market once the new product or service is launched, and the trend is set for other companies to follow. It also creates the opportunity for companies to become the market leader within the industry, to ensure growth, and increase profits.

Some key aspects were identified that companies could focus on to encourage an innovative environment. Most employees are willing to accept responsibility for the

innovative ideas, since this will benefit the company. Managers should take responsibility for their actions within the software development department, and reward employees that assist in reaching the goals set in company strategy.

The software development process should always include a step for quality and reliability. This step is needed, since even the most innovative product needs to be stable and reliable, otherwise the product will not be used by customers if they are frustrated.

Keywords: *Software development, innovation, Business Process Excellence, enhance, optimise, structured.*

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List of abbreviations

BPR – Business Process Reengineering

BPE - Business Process Excellence

IT - Information Technology

DFSS - Define For Six Sigma

DMEDI - Define, Measure, Explore, Develop, and Implement

DMAIC - Define, Measure, Analyse, Improve, and Control)

MET – Most Effective Technology

SWOT – Strengths, Weaknesses, Opportunities, Threats

SMEs - Small and Medium-sized Enterprises

SPSS - Statistical Package for the Social Sciences

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CHAPTER 1 – NATURE AND SCOPE OF THE STUDY

1.1 Introduction

Given today's competitive market scenarios and internally complex organisational structures, some software development organisations have managed to marry the seemingly contradicting strategic objectives of providing continuous added value to their customers and increased revenue to their shareholders (Anon., 2010:8-9).

Business Process Excellence refers to the documentation, review, optimisation and automation of business processes with the express aim to improve the productivity of your organisation (Anon., 2010: 8-9). Operating processes drive every area of business — from buying and selling, to delivering products and services, and to interacting with customers, suppliers and vendors. Improved business processes generate more profits and give the business a competitive advantage. Inefficient operating processes carve away at the bottom-line. The ability to measure and control the effectiveness and efficiency of these processes is essential to understanding the value they deliver. Business Process Excellence can be used to define these measures to create new processes for stimulating an innovative environment (Anon., 2010:8-9).

Organisations have designed and implemented effective and efficient business models that offer value, be it service, quality, low cost or variety to customers, as well as profits to shareholders. Having optimised processes is the only way an enterprise can successfully assert itself as a competitive business in the global marketplace. For that reason, businesses of the future will rely more heavily on innovative solutions and process management to improve existing processes and develop new business models and products (Anon., 2010:9).

Consideration was given towards the best process model, and the differences were considered between Business Process Excellence (BPE), and Business Process Reengineering (BPR). Business Process Reengineering (BPR) concerns the fundamental rethinking and radical redesign of a business process to obtain dramatic and sustained improvements in quality, cost, service, lead time, flexibility and innovation. BPR focuses on the whole process, starting from product conceptual stage to final product design. It provides the opportunity to reengineer the process, or to reduce radically the number of activities it takes to carry out a process with the help of advanced Information Technology (Hammer, 1990:104-112; Hammer & Champy, 1993:58; Peppard & Rowland, 1995:10). Although these authors could seem to be outdated, they are still seen as the leading experts on this topic.

The study determined the benefits that BPE creates for software development. Little research has been published on the topic of BPE and innovation. The reason for the lack of research on BPE is because BPE is a newly formulated term that has only been in use since June 2010, and innovation has not been the core focus of many organisations during the last 20 years.

Once the innovative environment had been established, an investigation was executed to evaluate how the innovative ideas and processes can be used to implement new products and services to customers, and create shareholder wealth.

1.2 Problem statement

Software development companies use predefined processes to implement new products and services. The processes are normally rigid, and have been used for many years. This contributes to the phenomenon that software companies seldom create or generate innovative products that offer their customers something unique.

The software development industry is a very competitive industry, and innovative products can increase the company's sustainable competitive advantage. Software companies also struggle to complete projects on time and within budget, and the study will determine whether the use of Business Process Excellence can assist companies not only to complete more projects successfully, but also to create innovative products that satisfy the demand in the market.

1.3 Importance of the study

Innovation is the only way an enterprise can successfully assert itself as a competitive business in the global marketplace. For that reason, businesses of the future will rely more heavily on innovative solutions and process management to improve existing processes and develop new business models.

These models and innovative ideas are generated by the employees, and their contribution to the success of the implementation of these innovative ideas is essential towards the growth of the organisation. The innovative ideas that are generated by the employees create wealth for the shareholder, and maximise the profits of the company. It is therefore essential that the organisation should reward employees to such an extent that they preserve their employees, thus maintaining a

competitive advantage with competitors in the software industry. By preserving their innovative employees, they also preserve the generation of innovative ideas.

1.4 Causal factors

The causal factors for this study were the following:

- The software development environment is primarily driven by structured processes, and most developers follow these processes, leaving no room for exploration of new ideas and innovative ways of creating value-added products for customers.
- Most software products that are distributed are products that have been requested by customers, and functionality has been requested by the users. The developers of these products do not create these functions based on innovative ideas within the software development company.
- Most innovative ideas generated are first seen as absurd and impossible to implement. Once these ideas are studied and explored for possible implementation a great new innovative product can be developed, and can lead to a new technology in the market.

1.5 Objectives of the study

1.5.1 Primary objective

The primary objective of the research was to investigate the possibility of using Business Process Excellence in a software development environment to create innovation, and new ideas for products that will add value for the customer, and also for the organisation's shareholders. The problem is that some organisations do not use these techniques, some seldom use them, and others report unsuccessful implementation and managing of quality assurance programmes. We will also recommend practical business processes that can be used to create innovative products and services to add value for customers, and create shareholder wealth. Since BPE is mostly used to optimise production processes for increasing productivity and efficiency, we used the framework in a software development environment, and adapted the framework to create innovation in the process.

1.5.2 Secondary objective

To achieve this primary objective of the study, the secondary objectives to be realised were as follows:

- Theory evaluation:
 - Perform a literature study to research the different aspects of innovation, and BPE, with emphasis on the software development environment;
 - execute an investigation to see whether these elements can be linked in order to assist organisations to develop new products and solutions for their customer, and create shareholder wealth; and
 - identify how other software development companies are creating new products and solutions through innovation.
- Empirical research:
 - Investigate the opinions of respondents on the use of BPE to encourage innovation in their organisations; and
 - investigate the readiness of these software development organisations to adapt to a structured environment for innovative products creation.

As can be seen from the above objectives, a number of aspects relating to BPE and innovation principles were researched. A survey was developed which was used to determine the level of adoption of the BPE and innovative principles by Compusoft South Africa Pty (Ltd), Pastel Accounting, and DCD Dorbyl (Vereeniging – Head Office). From the study recommendations were made regarding best practices to be followed when BPE is used to create innovative products in the software development phases in order to create wealth, both for the industry customers, and for the software development organisations.

1.6 Scope and demarcation of study

This study focussed on BPE, innovation concepts to assess the maturity level of innovation, and the use of BPE within the Software Development Industry in South Africa. The study confirmed how BPE can be used to create new products and solutions to ensure sustainable growth and wealth creation for shareholders.

The study was limited to primary sources of information available up to February 2011 and gained from the Software Development Industry in South Africa, with specific reference to companies such as Compusoft South Africa Pty (Ltd), Pastel, and DCD Dorbyl (Vereeniging – IT Department). Secondary sources of information were limited to those generally available on the Internet, in the form of English language documents, and generally available literature sources.

The empirical study focussed on Compusoft South Africa, and DCD Dorbyl (Head Office); all these facilities are either software distributors, or have a software development department within the organisation. The scope included all managers, programmers, analysts, technicians and specialists across all functions.

1.7 Research methodology

Both primary and secondary sources of information were used during the study.

Secondary sources from publications and textbooks were used to study the different BPE models, and also the effective use of innovation within the organisation. Primary information was also gathered by means of an empirical study. A quantitative research approach was used in order to be able to provide an objective base to meet the research objectives. Questionnaires were distributed to the relevant managers and specialists within Compusoft South Africa, and DCD Dorbyl (Head Office). All information obtained from the different business areas was kept confidential.

1.8 Division of chapters

This dissertation is divided into four chapters. Each chapter has different focus areas which are discussed in the section below.

1.8.1 Chapter 1

The aim of chapter one is to discuss the causal factors and to confirm the problem statement that forms the basis for conducting this study. A brief overview is given on the relation between competitive advantage, BPE, using innovation to create new products and services for customers, and create shareholders' wealth. A comparison is also made between BPE and BPR, and reason for using BPE instead of BPR is also given. The research methodology used as well as the target population is discussed.

1.8.2 Chapter 2

Chapter two consists of a literature study on BPE, and innovation within a software development industry. Wealth creation metrics and frameworks are defined. The literature study includes the identification of the best practices used by the companies that have successfully used BPE to create innovation of new products and services for their customers.

1.8.3 Chapter 3

Chapter three outlines the methodology used during the empirical study. A method of stratified sampling was used for the selected population. This type of sampling involves the division of a population into smaller groups known as strata. In stratified random sampling, the strata are formed based on the participants' shared attributes or characteristics. A random sample from each stratum is taken in a number proportional to the stratum's size when compared to the population. These subsets of the strata are then pooled to form a random sample.

The main advantage with stratified sampling is how it captures key population characteristics in the sample. Similar to a weighted average, this method of sampling produces characteristics in the sample that are proportional to the overall population. Stratified sampling works well for populations with a variety of attributes, but is otherwise ineffective, as subgroups cannot be formed.

A short overview of the Software Development Industry/environment is given. The design of the questionnaire is discussed as well as the sample design and process of analysis and evaluation of the data. The results from the survey questionnaires are presented in relation to the literature study.

1.8.4 Chapter 4

Chapter 4 presents a summary of the opinions from the respondents within the Software Development Industry on some best practices and processes used to create innovation within their organisations. A comparison of the maturity level of BPE and innovation between Compusoft South Africa, and DCD Dorbyl (Head Office) is presented. A list of practical business processes for the successful implementation of the innovative products is proposed. Final recommendations are

made to improve innovation within the software development industry. The dissertation is concluded by identifying opportunities for future research.

1.9 Conclusion

Innovation is needed in software development to create shareholder wealth, and a competitive advantage in the Software Development Industry. Innovation and creativity in companies are considered to be spontaneous and not subject to the process approach. Once the innovative environment had been established, we investigated how the innovative ideas and processes can be used to implement new products and services for customers, and create shareholder wealth. It is therefore essential that the organisation reward employees to such an extent that they preserve their employees for maintaining a competitive advantage with competitors in the software industry. By preserving their innovative employees, they also preserve the generation of innovative ideas.

Improved business processes generate more profits and give the business a competitive advantage. BPE can assist in these processes in creating optimised and innovative products and services for customers.

1.10 Summary

The aim of this study was to assess the impact that BPE has on the innovation process to create new products and services in the software development environment. The best practices currently in use for BPE in software development organisations were identified. Subsequently a proposal was put forward to improve the use of BPE in the software development process for creating innovative products and services. Once these products are implemented the organisation can use these products as a sustainable competitive advantage. The use of Business Process Excellence in software development creates an innovative environment for employees in order to develop innovative products that can create shareholder wealth, and increase market share. Companies want to create products that are unique to the market, and be able to offer their customers products that only they can offer, in order to secure future business.

The literature study will be discussed in Chapter 2.

CHAPTER 2 – LITERATURE STUDY

2.1 Introduction

This chapter is a literature study on the terms found in the topic of this dissertation. The building block technique was used to investigate each term individually. The study investigates how innovation leads to new products and creates shareholder wealth. Business Process Excellence was used in the software development environment to create these innovative products, and also discover that enhancing this process leads to a competitive advantage in the software industry.

Enhancing innovation refers to the implementation of a new or significantly improved product or process that turns knowledge into money (van Zyl, 2011:107). Innovation is also the source that gives the company a competitive advantage over its competitors since the most innovative company would be able to produce new products or services that would create a demand in the market, and increase the innovative organisation's market share (Akman, G. & Yilmaz, C., 2008:69-111). The focus of the study is on the Software Development Industry. Software development is already a process in itself, and if the process can be enhanced to create innovative products or services, it creates an opportunity for the company to offer its customer a product or service that is unique.

An investigation is done to determine the possibility of using Business Process Excellence in a software development environment to create innovation and new ideas for products that will add value for the customer, and also for the organisation's shareholders. Business Process Excellence is a relatively new concept used in companies that rely on the optimisation of processes to give them a competitive edge over other competitors in the market. Business Process Excellence uses the framework of the well-known Business Process Modelling methodology, and transforms the concept into an even better model by taking the process and adding an extra step that leaves room for exploration and innovation (Anon., 2010:8-9). Basically Business Process Excellence means that the "The process can always be improved".

The study aims to reveal how other software development companies are creating new products and solutions through innovation. A thorough investigation of the

opinions of respondents will indicate whether the use of BPE can benefit the organisation, and increase the company's market share when the software development organisation has adopted a structured environment for innovative product creation.

Recommendations were made regarding best practices to be followed when BPE is used for creating innovative products in the software development phases to create wealth, both for the industry customers, and for the software development organisations.

It is clear from the above that innovation plays a crucial role in the development of new products and services. Many organisations claim that they are innovative, and when asked how they achieve this, or to prove their statement, their reply is normally vague, and not structured. The use of innovation in the software industry was discussed to define the process and terms.

2.2 Innovation

Innovation is often confused with the term, invention. Innovation refers more to the process that is involved to create an invention (O'Sullivan, 2007:6). Invention is the creation of a new device or process. Innovation is the introduction of change via something new (Rouse, 1992). Innovation looks at a product or process in its current form, and restructures the product or process to perform better than before, or to be used for an entirely different application.

There exist many definitions for innovation, and below are some of the most popular definitions used today. It is important to look at all the different definitions for innovation, and invention to clearly distinguish between the two concepts, and to give insight and perspective to how innovation can be enhanced:

- *Definition:* "It has long been assumed that product innovations are typically developed by product manufacturers...innovators (with)...major influence on innovation research, on management of research and development and government innovation policy...series of studies showing that the sources of innovation vary greatly...test some implications of replacing the manufacturer-as-innovator assumption with the view of the innovation process as predictably

distributed across users, manufacturers, suppliers and others.” (von Hippel, 1988).

Interpretation: This definition focuses on the assumption that most innovative ideas would not only be generated by manufacturers, or innovators, but also by users, suppliers, and all parties involved in the industry.

- *Definition:* The origin of innovation – “Innovation is the result of
 1. a shock (a major failure) to the system,
 2. problematic search,
 3. random variability in experimentation,
 4. deliberate decision to invest in learning,
 5. match between a need and ideas which already exist,
 6. formal vehicles for stimulating innovation such as research and development,
 7. managerial risk seeking or risk adverse behaviour,
 8. availability of slack resources,
 9. management philosophy and organizational climate, and
 10. customer needs.” (Ijuri & Kuhn, 1988)

Interpretation: The above definition explains that innovation is derived from certain actions, or events that occur, and the result of these events is innovation.

- *Definition:* “Models that depict innovation as a smooth, well-behaved linear process do not specify the nature and direction of the causal factors at work. Innovation is complex, uncertain, somewhat disorderly, and subject to changes of many sorts. Innovation is also difficult to measure and demands close coordination of adequate technical knowledge and excellent market judgment in order to satisfy economic, technological, and other types of constraints - all simultaneously. The process of innovation must be viewed as a series of changes in a complex system not only of hardware, but also of the market environment, production facilities and knowledge and the social contexts of the innovation organization.

The five Central-Chain-of-Innovation steps include:

1. Invent and/or produce analytic design
2. Detailed design and test
3. Redesign and produce
4. Distribute and 5. Market “

(Kline & Rodenberg, 1986:275-304).

Interpretation: A process was identified for the complex well-behaved linear process of innovation. The definition also claims that innovation will not only change the hardware of the system, but also influence the market environment, and production facilities within the organisation.

- *Definition:* “Innovation cuts across a broad range of activities, institutions and time spans. If any part of the pipeline is broken or constricted, the flow of benefits is slowed. This is felt ultimately in lower productivity and lowered standards of living. In this sense, the cost of capital is crucial not only at the early stages of research and product development but also at the later stages when high-technology products are installed in production processes, in both manufacturing and service industries, as new tools to improve worker effectiveness” (Botkin, Dimancescu & Stata, 1983).

Interpretation: The definition focuses on the range of activities needed to order innovated worker effectiveness. If one of the activities in the process fails, this will decrease the benefits that innovation generates.

- *Definition:* “Continuous innovation occurs largely because a few key executives have a broad vision of what their organisations can accomplish for the world and lead their enterprises toward it. They appreciate the role of innovation in achieving their goals and consciously manage their concerns’ value systems and atmospheres to support it” (Quinn, 1986).

Interpretation: Innovation occurs due to some key people that have a broad vision of the organisation’s capabilities. These key people appreciate the use of innovation in their companies to maintain an innovative atmosphere.

- *Definition:* “Innovation is an idea, practice or object that is perceived as new by an individual or other unit of adoption” (Rogers, 1995:11).

Interpretation: Innovation is the generation of new ideas to either implement a new product, or enhance a current product or service.

For the purpose of this study the definition of Rogers (1995:11) will be used as mentioned above. The definition can be interpreted by saying that an innovation is the implementation of a new or significantly improved product (goods or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations.

Arnold (2010:8) also said that “Innovation turns knowledge into money”. The aim of any company in the world is to make money and create wealth for shareholders. However, if the company does not have the needed resources and knowledge for this, then innovation will not be practised in the company, and old methods will lead to loss of market share, and a negative growth rate.

An invention has no direct use in itself. An invention is functional only when it becomes an innovation, i.e. when it leaves the laboratory and when sufficient quantities can be manufactured or developed reproducibly at reasonable cost and made available to a target group. It follows that innovations must meet two major requirements (Mumford, 2000:313-351). The value of an innovation depends on the level of innovation and on its capacity for implementation. The level of innovation is determined by the creativity and the ideas of the innovator, who, in turn, is influenced to a considerable degree by the working environment. The potential for implementation of an innovation depends on the presence of a target group that is capable of assessing the benefits to be gained. Three subject areas must be of particular interest to innovative companies: customer orientation and service; flexible organisational structures; and creative staff. Customer orientation does not finish when the service or product reaches the end customer: It is characterised by the ability to think beyond the end customer to the requirements of the customer's market and the customer's customer. One must see through the eyes of the customer to ensure success. For end users, on the other hand, it is useful to provide an analysis of ways in which the product can best help them to achieve their goals. The customer demands not simply the solution of a standard problem, but the holistic solution to a specific problem which cannot, as a rule, be solved by the introduction of one technical product alone.

This definition extends the concept of innovation beyond the purely economic realm to that of social and organisational renewal, which is especially important in the African context.

2.2.1 Innovation or creativity

Creativity generates innovation. The term, creativity, is used predominantly to describe the work of artists, architects or marketing executives; it is seldom, if ever, used in connection with theoretical or applied science. Consequently, engineers are often the last people to be described as creative, although their job title actually indicates that their work is ingenious, or inventive. Creativity can be defined as the ability to link elements which are intellectually poles apart in such a way that the result is regarded as subjectively new and valuable. New information is by no means a prerequisite for the development of new ideas. A process is creative when information already available in various spheres of life and thought is arranged in an unusual way. Creativity requires a favourable environment which leaves sufficient freedom for it to develop. It is directly dependent on ability, desire and permission. The corporate structure must leave staff sufficient scope for creative freedom, in which ideas can breathe, free of the restrictions imposed by day-to-day business.

The most important factor that influences the success of innovations is innovative capability. Innovative capability assists in innovation success by providing interaction between customers and environment-related products that will be developed (Meeus & Oerlamans, 2000:85). Internal and external factors concerned with innovative capability are related significantly with innovation performance (Romijn & Albaladejo, 2002:22). Network sufficiency is one of the main characteristics of innovative capability, and is the most affecting factor of innovation success (Ritter & Gemünden, 2002:71). Because of inadequate researches related with innovative capability, market orientation and innovation strategy of software firms in the literature, there is a void. Therefore, the purpose of this study is to fill this void by developing a business process that will have an influencing innovative capability among small software firms in developing countries.

Research literature on innovation in established firms has made a useful distinction between radical innovation and incremental innovation and identified the organisational features associated with each (McDermott & O'Connor, 2002:11-30; O'Connor & McDermott, 2004:41), even while others have challenged the distinction between radical and incremental innovation as hard and fast categories to be flawed (Dewar & Dutton, 1986:101; Henderson & Clark, 1990:10).

2.2.2 Innovation in South Africa

South Africa's Technological Innovation Agency (TIA) was launched in Johannesburg on 29 October 2010. In terms of the TIA Act [No 26 of 2008], the object of the agency is to support the state in stimulating and intensifying technological innovation in order to improve economic growth and the quality of life of all South Africans by developing and exploiting technological innovations.

Innovation in software development can be regulated in certain ways, and software development companies should adopt this practice in order to use innovation effectively in their organisations. This regulation of innovation in software development forms part of the Business Process Excellence methodology to ensure that the company uses innovation optimally.

An essential aspect of innovation is the generation of new and context-specific knowledge, so the agency's mandate is to promote innovation to address the unique situation in South Africa, and the African continent as a whole. A key aspect of this unique situation is South Africa's young population with a median age of about 20 years. Most young people in South Africa are more technologically advanced than the Generation X population, for instance,

and the concept of software development is no strange environment for them (Van Zyl, 2011:13). This emphasises the importance of software development companies to employ young innovative people that have a natural tendency towards the idea of the effect of change and innovation on the company. An innovative company cannot be afraid of change, and be stuck in “old” ways; the company should be flexible. An innovative company should implement a learning environment that promotes innovation.

Companies may also require innovation for different reasons within their organisations. For example, a company may require complete process automation. A customer in this situation is not helped by a supply of control instruments. What is needed is a complete package including control instruments, software, assembly, installation, commissioning, service and maintenance. The value-added products described are very complex and varied and, thus, both time-consuming and costly to develop. Companies must have reached a certain size or have a flexible structure in order to meet the requirements. Large companies, for example, are in a position to maintain worldwide service sections in order to ensure maximum customer orientation. Small and medium-sized companies are forced to focus sharply on their areas of core expertise in order to survive in the international market. Collaborative partnership is an alternative strategy in this situation. It is essential, regardless of the size of the company, to minimise time to market for innovations.

When a market opportunity arises for a company which is not in a position to exploit it on its own, because the project parameters extend beyond the expertise of the company, it can seek partners who have the capacity to plug the gap. It can then enter into a temporary collaborative project which will enable it to take advantage of this market opportunity (Van Zyl, 2011:10). For this to succeed, it is essential to present the individual core expertise of each company and to create predefined interfaces so that any cooperation can be developed as quickly as possible, avoiding any friction at the interfaces. This process is supported systematically, and concluded with the generation of a partner profile which characterises the company and outlines interfaces and areas of core expertise in sufficient detail to ensure that nothing will stand in the way of the development of a collaborative enterprise. Thus, efficient collaboration with several companies to carry out complete projects becomes a core expertise of every qualified company.

The concentration of specialised areas of core expertise of various companies can further optimise the time-cost-quality triangle for their products and services. There is no wish for long-term cooperation between the companies. Each company has methods of approaching other companies independently and of developing collaborative partnerships. This mode of operation does not require the existence of a fixed pool of companies. Nevertheless, it is

envisaged that customer contact should be effected via a service company, which will cultivate contact with all qualified companies and integrate new companies. Innovations that are implemented in a company require a basis on which they can thrive (HARTY, 2010:297-315).

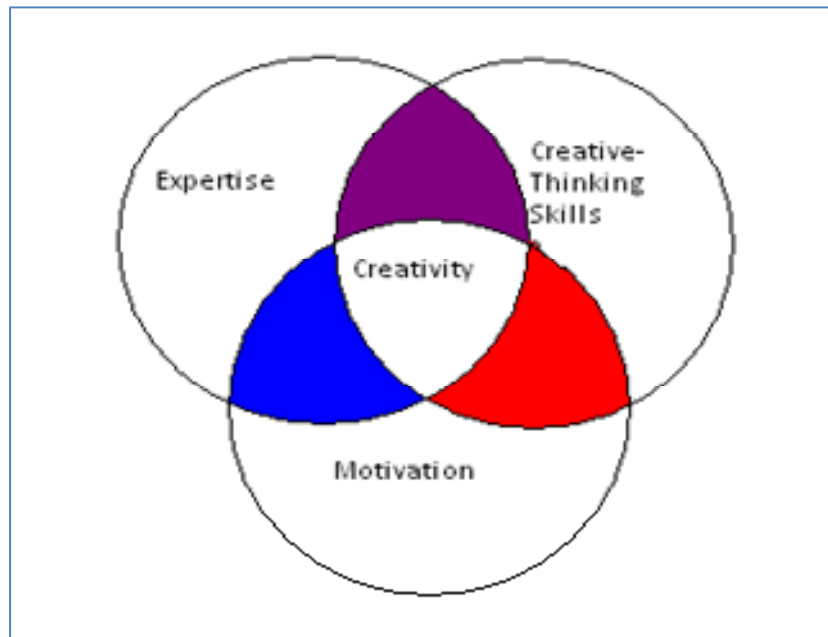
2.2.3 Creating an innovative environment for employees

Companies need to create an innovative environment for their employees. An innovative environment can be created using various tools that can be found in the White paper on creating an innovative portfolio (Schwarz, 2010:2), tools that have been developed to specifically manage the innovative process, and capturing these ideas to implement them successfully.

Consultants say the following elements are key elements to building an environment that can sustain innovation, and also explain Figure 2.1 on how creativity is generated:

- Give employees the right to fail. Create an environment that doesn't punish workers or hold them accountable for having tried something that ultimately didn't work. Motivate employees to use their expertise to be creative (**Purple** part in the figure below). It is hard to innovate when you are afraid to be wrong or make a mistake. Part of innovation is stretching or thinking outside the box and more often than not, you are wrong.
- Spread responsibility for innovation throughout the organisation, top to bottom. This can be seen as the **red** part in the figure below, since it emphasises the motivation of employees to use their creative-thinking skills. Anyone can have a good idea. Besides, if just a few people support innovation, it could disappear when those people move on to other companies.

Figure 2.1: The three components of creativity



Source: Amabile, 1998.

Develop partnerships with other departments. Encourage employees to combine their expertise and creative-thinking skills to generate creative ideas. To sell technology-driven innovations, IT needs to understand and articulate how it will help the company reach its goals. Ultimately, there are a lot of great things that can be done, but if they doesn't fundamentally drive something that affects the bottom-line, then they are just nice-to-have.

- Create a central repository for ideas and experiments. Garland likes the idea of innovation labs or centres, housed within the IT department, where people can try out new gadgets.

Establish processes and ownership. Organisations should have a process for taking a promising idea and testing it. Similarly, someone needs to take on the role of facilitator to prioritise and guide ideas through the development process. That person could be the CIO, an innovation officer or another key leader (Pratt, 2010:1).

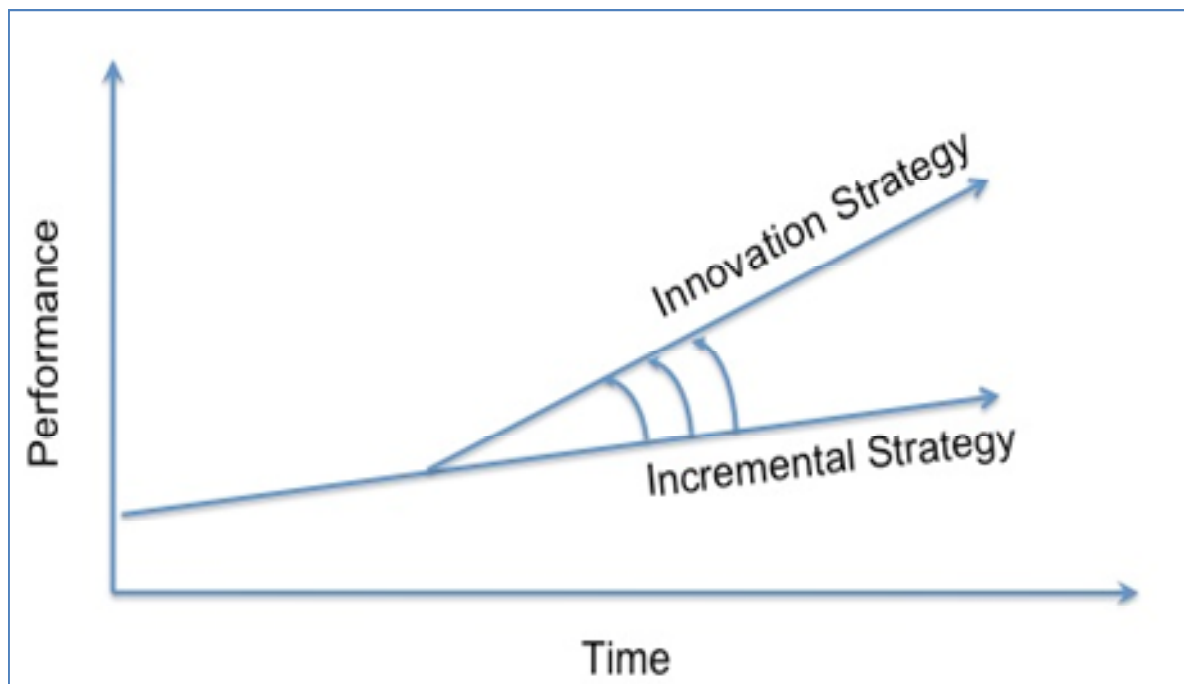
An innovative company's goal is more than new products. The company looks into reinventing business processes and building entirely new markets that meet untapped customer needs. Most important, as the Internet and globalisation widen the pool of new ideas, the goal is about selecting and executing the right strategy and bringing the strategy to the market in record time.

2.2.4 Innovation strategy

Innovation strategy contains activities such as development of specific new products and services, entering new markets and undertaking of great R&D projects (Manu, 1992). From this viewpoint, innovation strategy is one of the most important supporting factors for innovative capability. Firms might develop their own innovative capabilities by determining a suited combination of the dimensions of innovation strategy. At the same time, innovative firms also have a strong technological orientation (Cooper, 1985:9; Ritter and Gemünden, 2002:70). These firms generally undertake complex, high-risk and advanced innovation projects. These firms should have a strong innovative capability to carry out these innovation projects successfully.

The implementation of innovations is a topic of considerable interest for organisations seeking to achieve, sustain and increase their competitive advantage. Exploitation of innovation is routinely heralded by government and business leaders as the route towards better working practices and greater efficiency, and as a key element to opening up new opportunities and markets.

Figure 2.2: Innovation strategy performance



Source: Own illustration derived from the literature.

To create growth, sustain performance and develop performance in such a dynamic and changing environment, one way is to make innovations (Patel, 1999; Cottam *et al.*, 2001:4). It can be derived from the figure above that the innovative strategy increases the overall performance of the company rapidly, and contributes the sustainable competitive advantage.

Innovation has also received considerable attention as critical to securing sustainable competitive advantage in the market-place (Weerawardena, O'Cass, & Julian, 2006:425-438). Innovation activities are a critical factor for firms to develop their market position and to achieve success. In the market orientation literature, effects of market orientation on innovative activities are gradually gaining importance. Firms with innovative capability supported by market orientation are more successful in a rapidly responding environment, and in making innovations that provide high performance and competitive advantage (Gatignon & Xuereb, 1997:77–79). Market orientation is a basis for innovation, because innovation is a result of market orientation (Jaworski & Kohli, 1993:53–57). Market orientation is a required and important factor to constitute a suited environment for innovation (Baker & Sinkula, 1999:295–308). A market-oriented culture supports the innovative capability of a firm by encouraging openness to new ideas and innovation as a part of organisational culture, and it facilitates the application of innovations (Hurley & Hult, 1998:22). Market orientation is a behaviour that supports innovation because it contains response to changing customer needs with innovative strategies. Innovation is a main strategic tool to have a competitive advantage in such complex environments (Gardaker, Ahmed & Graham, 1998:172–177).

Recent research indicates that: (1) many established organisations achieve improved performance through continuous, small, incremental innovations (Gluck, 1985:413-424), and that incremental innovations are preferred by most established organisations as these are easier to implement within the operational constraints of the organisation (Mezias & Glynn, 1993:42); (2) incremental innovations can substantially reduce the risks involved in innovations and often can achieve cumulatively the impact of a radical or breakthrough innovation (Palmer & Brookes, 2002:71–83); and (3) incremental innovations bring more than incremental returns and large market share when the firm is prepared to be the leader in those innovations (Banbury & Mitchell, 1995: 82-161).

Some themes in incremental innovation that have been explored recently include: environmental, organisational and process factors affecting incremental and radical innovations (Koberg, Detienne & Heppard, 2003:21–45); focus of organisations on process management leading to efficiency improvements through incremental innovations (Benner & Tushman, 2002:676–706); differential impact of interdepartmental collaboration on radical and incremental innovations (Song & Swink, 2002); radical innovations being driven more by the technology champions and the environment, as opposed to incremental innovations being driven more by customers (Veryzer, 1998:21-304); factors increasing the speed of radical innovations (e.g.: concept clarity, presence of champion and collocation) having the

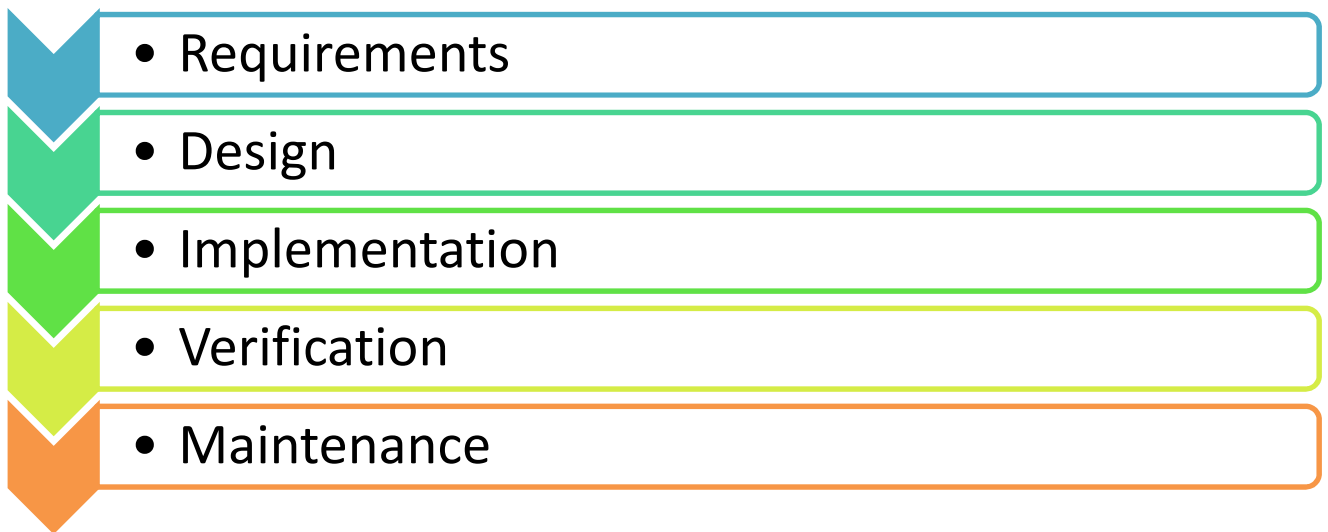
opposite effect on incremental innovations (Kessler & Chakrabarti, 1999:47-231); differential impact of contextual and structural factors (size of organisation, environmental uncertainty, specialisation, decentralisation of decision making and so on) on radical and incremental innovations (Germain, 1996:27-117); organisations' criteria for choosing a radical or incremental product development strategy (Ali, Kalwan & Kovenock, 1993:74-255); factors facilitating innovations related to technology and processes involving a high degree of new knowledge versus social services innovations with a low degree of new knowledge (Dewar & Dutton, 1986:1422); strategy and structure differences for radical and incremental innovations (Ettlie, Bridges & O'Keefe, 1984:682); and organisational interventions like search methods, communities of practice and so on, and their differential impact on radical and incremental innovations (Kieser, 1974:22).

The innovation strategy then needs to be implemented by means of the use of a tested and trusted process. The process should allow for an innovative approach towards the implementation, and ensure that the maximum potential is extracted from the innovative strategy.

2.3 Software development

The development of software is a complex task frequently resulting in unfinished projects, project overruns and system failures. Despite the progress made by the introduction of methods and techniques, unfinished projects, project overruns and system failures are still common. The limited success of technology-driven approaches has led to stronger focus on organisational and process-oriented aspects of software development (Nidumolu & Subramanian, 2004:159–196). As a consequence, several innovations in the field of quality management and Software Process Improvement (SPI) have been developed and are promoted for the software industry.

Figure 2.3: Software development process



Source: Royce:(1970 page).

Software Development (SD) comprises six steps as shown in Figure 3 above:

1. **Planning:** This deals with issues related to project scope, resources and schedule.
2. **Requirements analysis:** This defines the functional and performance requirements and the design and validation criteria.
3. **Design:** This transforms requirements into a set of architectural software representations.
4. **Coding:** This requires the use of a programming language to transform the design representations into a machine-intelligible format.
5. **Testing:** This is used to uncover latent defects and validate the software requirements of the program. It also attempts to assemble the software into a working package.
6. **Maintenance:** This involves keeping the system running and making necessary changes, as are required by the business. It involves the five steps from planning to testing.

In the present knowledge economy driven by technological innovation, the ubiquity and growing importance of software products and services are all too evident. Despite some fluctuations due to business cycles, organisations are continuing to invest in software products and services to stay afloat in a hyper-competitive business environment. (ITPro, 2007:7).

Despite the tremendous strides made in software development, as evidenced by the rich array of methods, tools, and techniques, about 19 percent of all software projects are never completed, while another 46 percent are categorised as “challenged.” These challenged

projects are operational, but over budget, over the time estimate, and completed with fewer features and functions than originally specified (Rubinstein, 2007). The growing frustration spurred by the dismal success rates of software projects, coupled with the imperative for responsiveness and agility, has ushered in an array of development methods that differ appreciably from traditional software practices. Several software luminaries, who were seeking alternatives to the traditional plan-driven software development, came together in 2001 to draft the Agile manifest. These new methods, labelled Agile Development Methodologies, aim to expeditiously deliver software of high quality and value to customers by emphasising the following: (1) collaborative and empowered teams unfettered by rigorous processes; (2) simplicity of design and minimal critical specifications, while documenting only what is absolutely necessary; (3) active involvement of preferably collocated customers; and (4) inevitability of change and an understanding that it may be leveraged through rapid iterations, feedback, and constant reflection on the consequences of actions (Cockburn 2002; Cockburn & Highsmith 2001; Highsmith & Cockburn 2001).

A singularly distinctive feature of these methods is the premium they place on collaborating and self-organising teams (Cockburn, 2002). SCRUM, eXtreme Programming (XP), Dynamic Software Development, Adaptive Software Development, Crystal Methods, and Feature-Driven Development are some of the more popular Agile methods. The growing popularity of Agile methodologies can be gauged from a recent survey of software developers, where 69 percent of respondents indicated that their organisations are using Agile methods and another 7.3 percent hinted that they should be going Agile in the next year (Ambler, 2007). Among the Agile methodologies, eXtreme Programming (XP), is by far the best documented and the most popular (Orr, 2002:7). XP is a collection of proven and not-so-proven practices of software development, combined into a coherent methodology. Proponents of XP insist on implementing all of the 12 core practices together, as they form a coherent system, compensating for the lack of significant up-front design and documentation (Beck, 1999:70-77). Despite gaining increasing favour among software developers, empirical research that sheds light on the efficacy of the core principles underlying such methods is still evolving. XP stipulates pair programming as a core practice, where two programmers, sharing the same computer, work collaboratively on all aspects of software development (Williams & Kessler, 2000:108-114). This practice of programming in pairs has attracted some research interest in the academic community. The oft-cited works of Nosek (1998:105-108) and Williams (2000) suggest that programming pairs not only outperform individual programmers on quality, but also produce fewer defects, are more confident of their solutions, and derive greater satisfaction from the problem-solving/programming activity. Other benefits of pairing reported by Williams include enhanced learning, higher problem-solving skills, and improved

team building. Pairing programmers of varying technical abilities is considered particularly beneficial for cross training and redistribution of technical expertise within project groups (Fruhling & de Vreede 2006:39-68). Several other studies have also attested to benefits of pair programming, such as enhanced software quality in large-scale software projects, reduced code defects, better designs, and enhanced predictability in development time and program size (Canfora, Cimitile, Garcia, Piattini & Visaggio, 2007:1317-1327; Cao, Mohan & Ramesh, 2004; Nawrocki & Wojciechowski, 2001:276-269; Phongpaibun & Boehm, 2006:85-94; Xu & Rajlich, 2006:500-505).

A recent meta-analysis of studies comparing the effectiveness of pair programming over individual programming reported moderate benefits in terms of quality and reduction in time to completion (Dybå et al., 2007). That study further reported a moderate increase in effort (person-hours) when developers pair up. Another recent study also attests to the benefits of pair programming and strongly advocates it as a pedagogical tool in programming courses (McDowell, Werner, Bullock & Fernald, 2006:90-95).

Some other studies, however, claim that pair programming is less efficient than reported by previous studies (e.g., Arisholm, 2007:70 ;Nawrocki & Wojciechowski, 2001:269-276). These studies could neither find pair superiority in software quality (Arisholm, Gallis, Dybå, Sjøberg, 2007:65-86; Heiberg, PussSalumaa, Seeba, 2003:215-224; Madeyski, 2006:278-289), nor uncover reduction in code defects (Hulkko & Abrahamsson, 2005:495-504; Nawrocki & Wojciechowski, 2001; Vanhanen & Lassenius, 2005). Consistent with prior literature (e.g., Nosek, 1998; Williams et al., 2000), the terms pair programming and collaborative programming are used interchangeably in this study.

2.4 Business Process Excellence

In this section a process model is investigated that allows for innovative thinking within the organisation and its processes. Optimising a business process alone does not mean that new and innovative products will be created. Business Process Excellence is the name for a new discipline that makes organisations fit for global competition. Businesses of the future will rely more heavily on innovative solutions and process management to improve existing processes (Anon., 2010:8).

Business Process Excellence can be used to recognise deviations quickly and correct them with appropriate measures, or even predict potential error (Anon., 2010:9). Excellent processes connect management, employees, external partners and customers at different locations. The process is also highly flexible so that it can be adjusted rapidly to suit changing market or environmental conditions. This is how businesses create a basis for

realising new business models quickly, and even integrate third-party suppliers into their own value chain efficiently. Key Performance Indicators (KPI) help an organisation reach its goals in areas including customer satisfaction, service/product quality and profitability.

In the continuous improvement of business processes, managing these processes becomes a process in itself that is implemented and executed within the company (Anon., 2010:8-9). Since the optimisation of processes is discussed, the use of Business Process Reengineering cannot be ignored, because this process has been used in many organisations to optimise their productivity. In this study preference is given to the use of Business Process Excellence in order to optimise the productivity, and generate excellent products and services for customers.

2.4.1 The difference between Business Process Reengineering, and Business Process Excellence

Business Process Reengineering (BPR), which entailed finding radical new ways of performing business operation, usually with the aid of information technology (Chaffy & Wood, 2005:387), emerged in the 1990s. Although BPR intended to improve cost, quality, speed and productivity, reengineering soon became associated with downsizing, lay-offs and low staff morale (Melao & Pidd, 2000:108).

Much has been published about the successes and failures of BPR during the last decade of the twentieth century. Some authors quote failure rates of between 50% and 75% (Hall *in* Ahmad, Francis & Zairi, 2007:451; Grant, 2002:85; Varghese, 2004:13). On the other hand, better quality products, more responsive services, increased company revenues and better share values are quoted by other authors (Hammer & Stanton, 1999:144).

Business Process Excellence (BPE) has a more positive approach to improve a business process ultimately. BPE is also used to improve the business operations, but uses a further step to allow for innovative thinking, and using its resources optimally. BPE uses a factor for exploration of new ideas and thinking, in order to create innovative products for increasing shareholder wealth (Anon., 2010:8-9).

Operating processes drive every area of business — from buying and selling, to delivering products and services, and to interacting with customers, suppliers and vendors. Improved business processes generate more profits and give a business a competitive advantage. Inefficient operating processes carve away at the bottom-line.

Clever companies that have complete control over their business processes are able to realise the full potential of their organisation's productivity. Business Process Excellence

(BPE) in a nutshell refers to the documentation, reviewing, optimisation and automation of business processes with the express aim to improve (enhance) the productivity of the organisation (Anon., 2010:8-9).

BPE Benefits include the following:

- Documents and "institutionalises" knowledge and experiences, reducing organisational vulnerability;
- critically reviews and optimises key business processes for effectiveness and efficiency;
- improves organisational knowledge of its intellectual property;
- automates and controls processes that were previously difficult to manage; and
- improves organisational productivity.

It is clear that Business Process Excellence is a useful tool to assist in optimising the processes in the organisation. The question to be asked, is, "How can Business Process Excellence assist in software development?" One of the objectives of this study is to research both concepts, and then determine whether the two concepts are related at all. Saying this, it was derived that the two concepts are integrated, meaning that the one cannot do without the other in order to develop innovative products that add value for the customer.

2.5 Enhancing the innovation process

Creating better innovative ideas flows from a process that stimulates ideas, and that gives opportunity to the most unrealistic ideas.

To achieve continuous improvement, firms must promote organisational learning to enhance knowledge that can be utilised in the future (Baker & Sinkula, 1999:425). Today organisations in the global world are discovering new ways for realisation of ambitious plans of development and achieving better results. Companies need simultaneously to pursue and create synergy between opportunity, growth, profit, humanistic values and social good. As a formula for the future it brings together the necessity of the financial success that shareholders demand and the social conscience demanded from the new generation moving up the corporate ranks. (Kanter, 2010). Salmon (2004) is of the opinion that "the future belongs to those who are able to abandon the analysis for the sake of synthesis of knowledge, rationalistic thinking in the name of polysemous vision, for those who are able to think systematically" (Salmon, 2004). The future must be created not only by state policy makers, but by those working in various organisations, justifying their acquired qualification of the bachelor's or master's degree, showing more innovative results in the chosen or delegated field of their responsibility. Employees must increase their productivity during

creativity-oriented thinking, self-efficacy learning and innovative moving at the working place. Most innovative products have already been developed; they have just not been released to the market, or introduced to the users.

Once this increase in productivity is reached, and the innovative products are being implemented, confirmation needs to be given that the quality and reliability of the product is high. A product can be extremely innovative, and create a huge demand in the market, but if the consumer or customer finds that it causes more frustration due to malfunction and error, then even the most innovative product will become obsolete.

In the next section the need for employees to change their mindset is discussed in order to enhance product quality and reliability.

2.5.1 Changing mindsets

Getting information technology companies and academic researchers to invest resources in creativity-related research and development, requires at least three significant changes in mindsets.

- Developers, who understand that benchmark task completion is giving way to playful exploration, richer search features, generation of multiple alternatives, and easy backtracking with rich history keeping. They also recognise that Web-enabled social creativity environments can support innovative approaches to software development, content creation, and rapid dissemination of new ideas.
- Product managers, who conceive of their customers as creators, rather than merely users or consumers. They are already changing their requirements analysis, feature selections, and marketing strategies. They know creative people want open systems that they can extend, and that they want an audience, feedback, rewards, and recognition.
- Researchers who study and evaluate software usage. They are getting past old strategies of controlled studies and short-term usability testing to embrace ethnographic styles of observation, long-term case studies, and data logging to understand patterns of usage. They know that motivation, empathy, playfulness, and surprise are part of the creative landscape. They also know that getting the correct combination of individual discovery, supportive consultation, and community brainstorming generate high user engagement.

These changes to expectations for individuals and their institutions are important first steps in enabling more people to be more creative more often (Shneiderman, 2007). However,

even with clarity about the goals, there are still numerous challenges such as developing design.

2.5.2 Enhancing software reliability

Software reliability is an issue of ever-increasing importance. As software grows in both size and complexity, end users are demanding enhanced service and zero downtime, and industry itself is placing greater and greater demands on software developers by continually raising standards (Hudepohl, 1997:1).

We need to identify and define what should be measured in each step of the SD process. It is wise to use a process that produces an output that can be effectively measured at every step of the way. Considering what should be measured early in the process forces developers to pay attention to measurement parameters, measurement methods and product outputs. The SDP, the output, the measurement process, the measurement parameters and the measurement tools should all be considered simultaneously. Current SD practices do not operate in this manner, and so the only time the issue of measurement is considered is in the testing stage. This is too late to significantly improve the development process without incurring greater development costs. (Kendall & Kendall, 2004:35; Johnson, 2005:58).

2.5.3 Enhancing software quality

Software quality has become a topic of increasing importance during the past decade. The quality of software is primarily determined by the quality of the software development process. Even small improvements in the software development process can result in a significant improvement in software quality.

Many models like the Life Cycle model (Hosier, 1961:54; Royce, 1970:87; Boehm, 1976:65; Distaso, 1980:35; Scacchi, 1984:10; Somerville, 1999:47); Waterfall model (Royce, 1970:72), and Spiral Model (Boehm, 1986:20) exist to guide any software development process to optimise the process, and to get the best quality development, and software from the process. Business Process Excellence creates space for innovative ideas in the “explore phase” which allows for many innovative ideas to be shared.

The fundamental problem with the SDP is that defects found in the testing phase occur in one or more of the earlier phases, but there is no genuine attempt to address defect elimination early in the process. What is needed is a structured process ensuring that the basic objectives of each step are satisfied, and the root causes of the problems are detected and eliminated before moving to the next step. The lack of such a structured process to

identify the root causes is a fundamental problem with current software development practices (Cockburn & Highsmith, 2001:131-133).

A systematic approach is needed that ensures a consistent level of product and process quality that is easily measured throughout the development process. The SDP in its current form leads to poor product quality because it does not ensure that each of the six phases produces defect-free products. Research suggests that software defects found in the latter stages of the development life cycle are ten times more costly to fix than those found early in the process (Kendall & Kendall, 2004:60). It is not suggested that the entire SDP is flawed because some organisations employ techniques such as code walkthrough, program inspections and total quality management. (Code walkthrough is a set of procedures for software error detection). The problem is that some organisations do not use these techniques, some seldom use them, and others do a poor job implementing and managing quality assurance programmes.

SD is practised in a reactive, rather than a proactive manner and this is the fundamental limitation of the process. The use of a consistent proactive approach is suggested to identify and fix defects at every step of the process. In the absence of this approach a defect-free product cannot be guaranteed at the end of the process. Practitioners take it for granted that problems that go undetected will be discovered in the testing stage. They fail to recognise that testing cannot discover all of the problems. The more problems are deferred to the testing stage, the greater the likelihood that developers will miss more of them. This also increases the likelihood of cost overruns and longer delivery times (Nidumolu & Subramanian, 2004:159–196; Strahl, 2001:29)

2.5.4 Enhancing the software development process

To enhance the software development process, a fast, agile development process is created. The question can be asked whether companies have the structure and tools in place to rapidly cycle, test, and receive feedback. Another question can also be whether developers take too much time to develop "perfect specifications" in nearly finished products and putting them out to test the market, only to find that these near-finished products are widely off base. Design firms are especially agile in developing understanding of users, creating prototypes rapidly, and testing these with users along the way to market-ready products or services. As one of the design leaders in our study said, "No product is perfect". Companies waste too much time trying to achieve the perfect solution before getting to market. The only way to really improve a first generation product is to learn from customers who have paid for something and want to see it improved. In many applications, very affordable prototyping tools can accelerate a team's productivity. In mature R&D

organisations, releasing an R&D team from centralised tooling departments, internal suppliers, and pilot production facilities can unleash a barrage of political noise—but such flexibility might be essential for more radical innovations to succeed in mature corporations.

Implementing innovation processes and methods requires balance and judgment. You need to have a high-level framework that guides how innovation will progress and you need to be able to adapt the approach. Flexible teams are fast teams. Empowered teams figure out new ways to innovate and develop tools. Overly constrained teams fall into process mode. They think about check boxes, phase deliverables, and identified methods that may not be appropriate. You can't be too prescriptive and you can't be too loose. The balance is critical. Companies have seen great success by having a high-level understanding of a framework for development that is combined with an openness to allow teams to customise the exact approach.

2.5.5 Adding value, and measuring productivity

Enhancing a process or product also means that value has been added to the product or process in order to make it better, and achieve better results. Whether the results are measured in quantity or profits, companies strive to add value for their customers by using innovation, enhancing current products or services.

One of the most important discoveries of Value-Based Management (VBM) – a concept assuming a company's value maximisation as its ultimate goal – is its fresh look at company performance measurement and management. The VBM literature is full of presentations of various metrics that can be used to gauge and drive financial results. On the one hand such a wealth of measures seems to be beneficial because one can choose the method that is the most customised and suitable, but on the other hand it can be confusing, especially for those who do not have a sufficient financial background. For example, the potential user of value-based metrics may not know that some of them are very close substitutes while others should be considered rather to be complementary measures that can be used together. What's more, business consulting firms promote their own variants of value-based metrics as exceptional and one of a kind propositions while – in fact – they do not differ much from competing measures of other consultants. An informed choice of a particular value-based measure or measures must be based on a deep understanding of the similarities and differences among them.

According to Vrat, Sardana & Saha (2009) efforts to increase productivity started from business management. Most organisations fail to understand the meaning of productivity in its implementation due to the organisational emphasis on the reduction of input, but at the

same time want to produce more output (Baines, 1997a:49-51). Technically, productivity can be defined as a measure of the amount of output obtained from a certain amount of input (Mokhrat, Nooreha, Nik Mustapha, & Mazilan, 2003:20-84; Kapyla., Jaaskleinen & Lonngvist, 2010:5, Baines, 1997b; Sahay, 2005:61, Johnston & Jones, 2004:74; Vrat *et al.*, 2009:23). It can also be interpreted as the use of various resources or inputs in the organisation to achieve the planned or desired results (outputs).

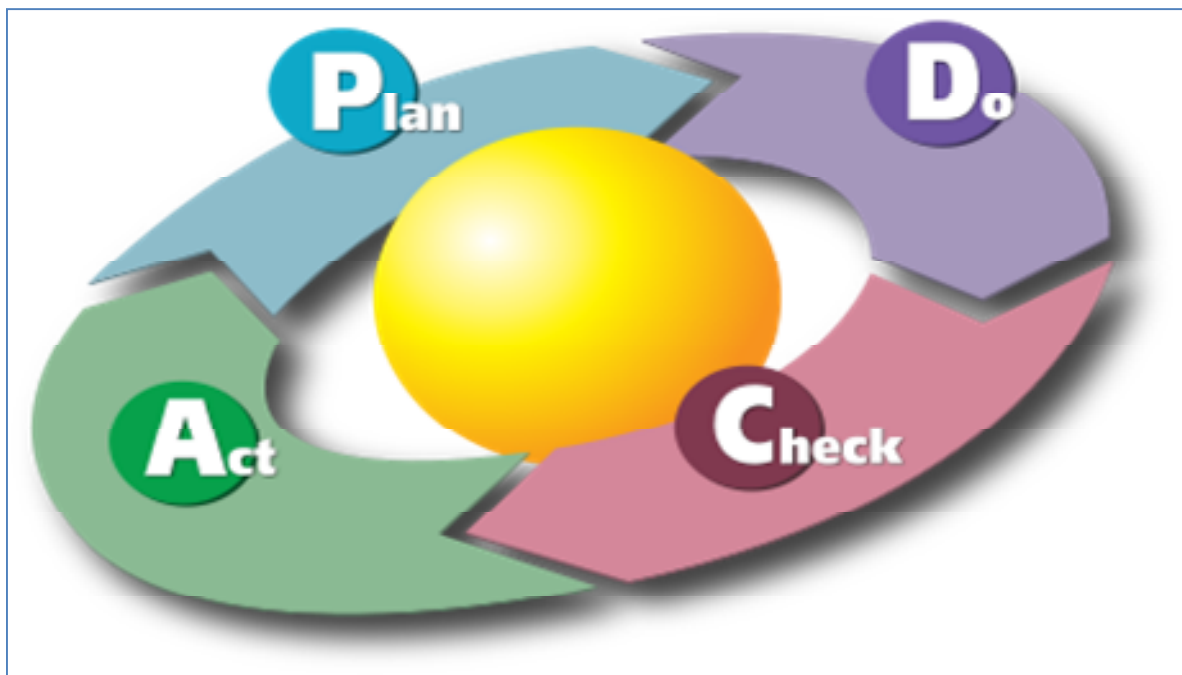
Indeed, measuring the productivity can be complex (Baines, 1997b; Sahay, 2005:54; Johnston & Jones, 2004:87), but its importance in the organisation cannot be denied (Baines, 1997b). There is a gap in the literature review that did not discuss the specific issues of values that support the productivity of the organisation. The literature is mainly focused on the definition of productivity and method of its execution only (Johnston & Jones, 2004:33) as measured by labour productivity and capital gains only (Baines, 1997b:21). A study by Sahay (2005:55) in the service organisation revealed the multi-factor productivity model which involved only static factors, dynamic and development parameters in calculating the overall productivity of the organisation. Besides that, issues such as effective communication, involvement in decision-making and providing feedback are important in productivity (Baines, 1997:11). Literally, the amount of output produced in excess of the same amount of input is said to be having increased productivity. In short, the quality is associated with a service or product, but productivity is related to the size of the effectiveness of human resources in an organisation. Baines (1997:11) also reiterated that productivity is more just and appropriate in evaluating the performance of services, as the issue of productivity assessment is given less attention in the services sector (Sahay, 2005:56; Johnston & Jones, 2004:34). Thus, the factor of productivity refers to initiatives for improving the employees' productivity for organisations to function more productively. Use of information technology is one example of initiatives that lead to improved performance of employees within the organisation (Mokhtar *et al.*, 2003:87). The process of upgrading from time to time in all its aspects is necessary in the organisational transformation (Sahay, 2005:55). A set of values are capable of causing the organisation to function more efficiently by setting goals for the entire organisation (Pratt & Kleiner, 1989:22). Achieving high productivity is the goal of each organisation (Kleijnen *et al.*, 2009:87). Organisational values are important in improving productivity (Pratt & Kleiner, 1989:45; Aqeel, Akbar, Husain & Khan, 2010). To improve productivity, it should be measured (Vrat *et al.*, 2009:43) and, in this context in terms of intangibles, be indicator of core values. Besides that, the ability to manage and coordinate the existing potentials in each individual employee can also increase productivity (Mustapha, 2003:66).

2.6 Enhancing quality control in software development

In this study it was discovered that Business Process Excellence can be applied in such a way that the software development process is enhanced in order to develop enhanced products and services.

A model that can be used to enhance the quality of a process is the **Deming Circle** model. This methodology will be used in Chapter 3 to measure the effectiveness of Business Process Excellence in the enhancement of software development.

Figure 2.4: The PDCA cycle



Source: Deming, 1986

Deming who helped to rebuild Japan after the Second World War developed the model. One of the things he specialised in was 'quality'. The Deming Circle is a mindset of continuous improvement. Deming also invented the PDCA cycle, a repetitive set of steps that you should use in any process within your company. The model is particularly useful when you are approaching something new. Here is what you do:

Plan - Plan what you are going to do. Document it (if need be).

Do - Do a pilot of what you have planned.

Check - Check the results of what you have done. Has it worked? Could it be improved?

Act - Do the real thing, after making adjustments from the previous step.

The process is then repeated from the Plan stage. It is a continuous circle of improvement. When you implement this strategy you are basically creating a hamster wheel, one from which you can never really get off (because you are looking for continuous improvement all the time). It is important to celebrate your milestones and know when you have arrived at your goals. Always strive for better, but sometimes accept the current way of getting the job done. (Jesson, A., 2010:51)

One way of measuring the quality in software development is the DMEDI methodology. DMEDI (Define, Measure, Explore, Develop, and Implement) builds from the improvement methodology but it includes an “explore” step. One misconception regarding Six Sigma is that it is only useful for improving an existing process (Costa, 2005:14). While it is true that DMAIC (Define, Measure, Analyse, Improve, and Control) is and should be used to improve existing processes, there is methodology that can be applied as new innovative processes are designed and implemented. This methodology is called Define for Six Sigma (DFSS). Having established that Six Sigma can support both the development of new processes and the improvements to existing processes, there is another concept to discuss that will drive value to the bottom line even faster. That concept is called Implement MET or “Most Effective Technology.” MET is comprised of three levels:

- Corporate leverageable technology, referred to as MET-1;
- business leverageable technology, referred to as MET-2; and
- location specific technology, referred to as MET-3.

For the purposes of this model, technology encompasses both the process and the underlying technology to support the process. Each process owner is responsible for the MET supporting his or her particular operations (Costa, 2005:15).

This model was not used in the calculation for quality in chapter 3, but can be used as one of the quality control methods when business starts to implement the Business Process Excellence model.

2.7 Conclusion

According to the literature the usage of Business Process Excellence to enhance innovation in software development can generate a competitive advantage for organisations. Innovative products give customers and users the unique benefit that none of their competitors have, and thus bind them to the current software system supplier. They also secure future business and profit growth for the software development organisation.

Organisations therefore need to ensure that their employees have the needed skills, knowledge and expertise to develop innovative ideas that can be of benefit to the company. Employees should be encouraged to continuously create new ideas, and think of new ways to produce the same product or service, or even create a product or service that is better than the previous model. Rewarding employees for this type of thinking, and positive ways of thinking can encourage them to maintain an innovative environment in which the company can grow from strength to strength.

Business Process Excellence gives the user (customer) a complete system that incorporates both requests and innovative services that increase the productivity, and quality of the software system. The quality that is generated in the software system can only be of high standard if the software development team uses a high quality process to develop the software system. Since nowadays most companies rely heavily on their operating software systems, it is important that much thought is given to the way the implementation of the system is done. Even the most impossible idea can become reality. The systems must aim to move the company forward, and maybe even to take one giant leap forward to become a market leader in innovation.

2.8 Summary

It can be summarised that innovation is a key factor to enhance processes within the software development company. Enhancing the processes can generate new ideas that contribute to the sustainable competitive advantage of the company. The literature does not create a definite link between the use of Business Process Excellence and innovation, and the study aimed at evaluating the possibility to merge the concepts.

Business Process Excellence optimises a currently implemented process, by exploring all ideas to increase the effectiveness of the system. It is a structured way to ensure that all possibilities are explored before a decision is made on how the process is structured to implement new products or services.

The software development industry is a very competitive industry, and most companies do not share their competitive strategy, or make it available to the public, thus ensuring that they would be offering their customer something unique. These companies would only make their strategy known to the market once the new product or service is launched, and the trend is set for other companies to follow. It also creates the opportunity for companies to become the market leader within the industry, ensure growth and increase profits.

CHAPTER 3 – EMPIRICAL STUDY

3.1 Introduction

Measuring Innovation is a challenging task since innovation is an abstract concept, and quantifying the results is not always possible. In this chapter the focus was on the research methodology used to help meet the research objectives as laid out in 1.4. In addition, the findings from the survey and interviews are presented. Ultimately, innovation is a means to an end — a competence for generating profitable growth opportunities and improving the organisation's competitiveness. Many software development companies also encourage an innovative atmosphere, but never implement processes to ensure that the innovative ideas are implemented and tested to generate unique products and services for the market.

3.2 Locale of the study

Research was conducted on the Software Development Industry. The software sector is an advanced technology sector. It is characterised by high-rated product and process innovation, high knowledge intensity, very short product life cycles, rapidly decreasing product value, global market, intensive competition and a world-wide value chain (Nambisan, 2002:55). Software firms could be defined as innovative firms that use technology, marketing and organisational strategy successfully to have a strong situation with new products. They use technology and innovation as a competitive tool. They have an open strategy, and generally their strategy is based on creating change, catching opportunities and exploiting all opportunities. Because of these attributes, the software industry is suited for innovation studies.

3.3 Population sampling

A method of stratified sampling was used for selecting the sample population and to test the sample for reliability. This type of sampling involves the division of a population into smaller groups known as strata. In stratified random sampling, the strata are formed based on participants' shared attributes or characteristics. A random sample from each stratum is taken in a number proportional to the stratum's size when compared to the population. These subsets of the strata are then pooled to form a random sample.

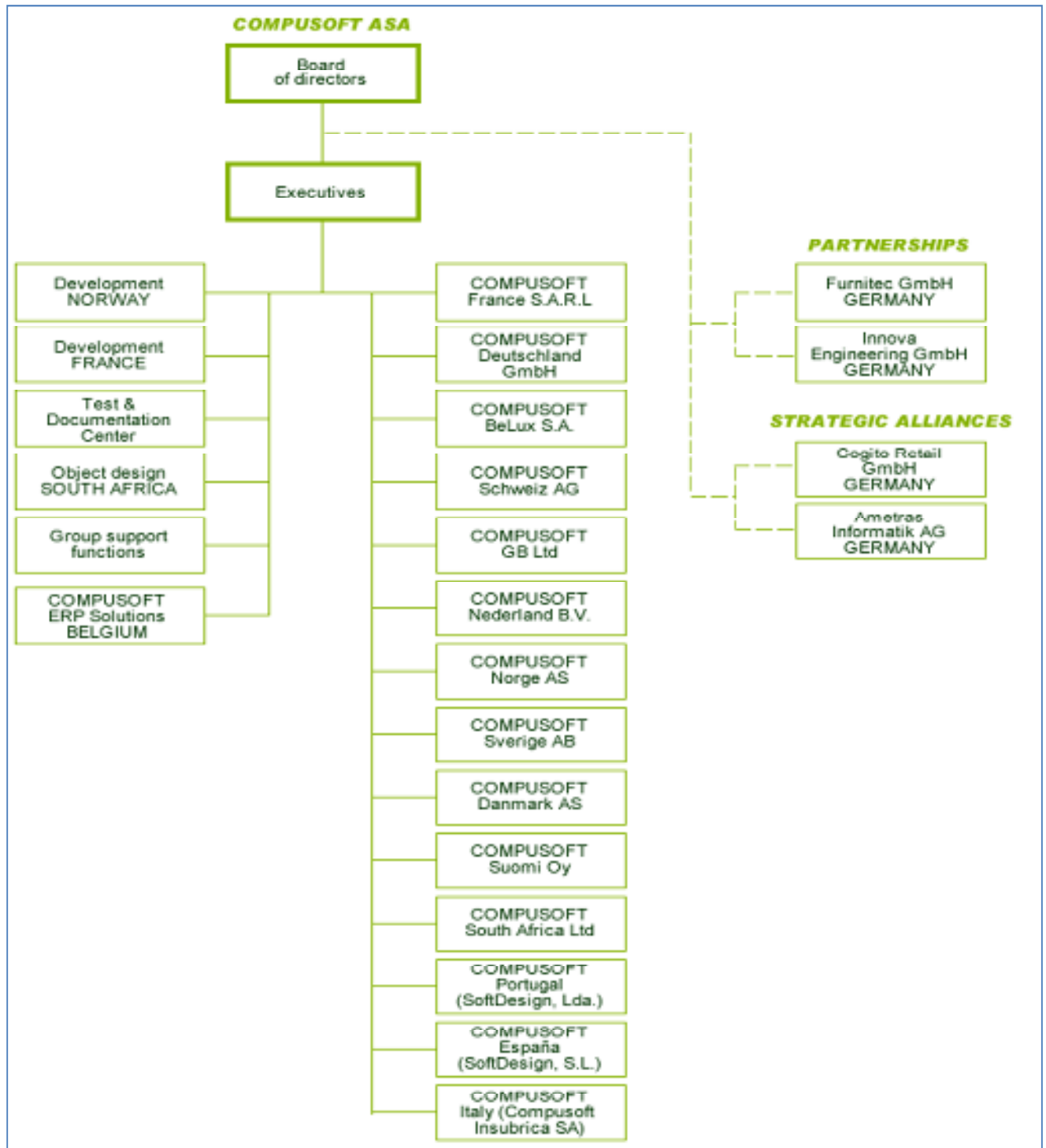
The main advantage with stratified sampling is how it captures key population characteristics in the sample. Similar to a weighted average, this method of sampling produces characteristics in the sample that are proportional to the overall population. Stratified sampling works well for populations with a variety of attributes, but is otherwise ineffective, as subgroups cannot be formed. Therefore, the software sector was selected as

an area of research to achieve goals of the study easily. Questionnaires were sent to the following software firms:

- Compusoft ASA – Norway
- MineWare
- Signify Software (Pty) Ltd
- North West University (School of Information Technology)

Compusoft ASA – Norway is a Compusoft firm that provides software solutions and services for kitchen and bathroom design. This has been its core business since the company was established in Norway in 1989. Compusoft has 18 subsidiaries in 14 countries and some 230 full-time employees, including development teams in Norway, France and Germany. Compusoft's choice to set up this service network through 100%-owned subsidiaries has the clear advantages of closer communication and customised service to customers.

Figure 3.1: Organisation chart (Compusoft ASA)



Source: <http://www.compusoftgroup.com/content/about/organisation.aspx>. Date of Access: 1 Nov 2011

MineWare was found in 1996 by Paul Saker; MineWare Consulting offers software solutions tailored to the dynamic and growing mining industry. The company has grown from a small family enterprise into a preferred software supplier in its chosen industry. Most of the

MineWare team have direct mining experience from various disciplines across the mining sector, and by combining this experience with information technology and business expertise, they provide the perfect knowledge base with which to deal with any software problems. MineWare not only develops customised software, but adapts and redesigns a client's current products to ensure seamless integration of the system and easy understanding for operators. It is this flexibility that has brought the company success in South Africa's mining industry.

Signify Software (Pty) Ltd was founded in 1999 as a software development company that specialised in the management of legislative processes such as Employment Equity, Skills Development and FAIS. Their product range has since grown to include a Performance Management, Learning Management and complete Human Resource Management solution. Signify HR is modular, enabling you to implement the different modules over a period of time as and when required. Signify serve a wide range of companies, ranging from 50 employees to 50,000 employees. The modules implemented at these companies vary from single modules such as Performance Management to their complete HRM solution. Their offices are located in Centurion, South-Africa. They employ qualified senior staff and have partnerships with organisations in complementary fields of interest. Through these relationships, they have access to highly qualified resources. This complements the range and level of services they are able to offer their clients. They continuously strive to provide users with excellent service and quality products and to play a significant role in the success of their customers and users.

North West University (School of Information Technology) – is part of the North West University for Higher Education. The School of Information Technology is committed to quality programmes and graduates. New programmes have been introduced since 2010 to make more choices available to students and to fit their needs and those of the market better. Since 2010 Business Mathematics and Informatics (BMI) programmes are being offered at the Vaal Triangle Campus. All the BMI programmes focus on Risk Analysis and Management. They also offer curricula to students who wish to combine Computer Science with Economics or Statistics. The survey was completed by 22 students that are currently enrolled in the BSc It Hons degree. Most of the students are already employed at various software companies as software developers.

Returned questionnaire number is 33. Therefore, 32 questionnaires were evaluated by SPSS 12.0 (SPSS, 2009), and Statistica statistical software (StatSoft, 2011).

3.4 Instrumentation and data collection

There are various methods that can be used by researchers for capturing the information needed. The schools of thoughts can be grouped into two, namely qualitative and quantitative approaches. Qualitative research is a subjective approach (Neill, 2007). In this approach the individual's interpretation of events is important; for example, the participant observation during an in-depth interview. **Qualitative** research involves analysis of data such as words (as from interviews), pictures (such as video), or objects (such as an artefact).

Quantitative research is an objective approach. This method seeks precise measurement and analysis of target concepts. Researchers use tools such as surveys and questionnaires for gathering the data needed. The quantitative research approach is less time-consuming and the data are in the form of numbers and statistics.

Both a qualitative and a quantitative approach were chosen by the author in order to meet the research objectives objectively. The design decided upon for the study was a non-random purposive sampling approach. The intent was to get the maximum number of responses possible within the time frame available. The survey instrument used in this study was an open-ended questionnaire for the qualitative approach, and a Likert scale structured survey for the quantitative approach. The advantages and disadvantages of using a questionnaire were considered and they justified the use in this study. The questionnaire consisted of 9 open-ended questions forming the qualitative part of the study. For the quantitative approach a 42 question survey was used with answering in the form of Likert scale. The scale of each question was determined by the appropriateness of the question asked. Provision was also made for a selection of "Do not know" if the respondent did not know the answer to the question, since the term "Business Process Excellence" is a very new term and process. The interview questionnaire is included in Annexure A. The survey questionnaire is included in Annexure B. The questionnaire was sent via e-mail to all respondents as an attachment; respondents could fax the completed questionnaire back and remain anonymous.

3.5 Sample group and size

The main target population of the study was the management and software development staff in three major software companies and a group of students. Two of the three software companies are within the South African borders, and one (Compusoft ASA) is located in Europe (Norway). An Interview was also conducted with all the software development

managers. The sample covered a broad spectrum of participants of mixed race, gender and work experience at different levels within the organisation.

A full breakdown of the number of employees found in the different companies in the software development department is summarised in table 3.1.

Table 3.1: Sample group

Company name	No of staff in department	Surveys received
Compusoft ASA – Norway	11	11
MineWare	1	1
Signify Software (Pty) Ltd	3	2
North West University (School of Information Technology)	30	22

It is clear from the small sample group that most software development companies were not interested in completing the survey. Some companies to whom the survey (Arcelormittal, Maxxor) was also sent did not even respond to the invitation. Even after several phone calls, and e-mails, these companies failed to respond. It was made clear to all respondents that the information obtained will be kept confidential. The survey was also e-mailed to all potential respondents, with the choice to either return the survey by facsimile, or e-mail. Anonymity was also guaranteed to all respondents.

It can be said that we have an **availability** sample. An advantage of drawing a random sample is that it enables one to study the properties of a population with the time and money available. In such cases the statistical significance tests (e.g. t-tests) are used to show that the results (e.g. difference between two means) are significant. The p-value is a criterion of this, giving the probability that the obtained value (or more extreme) could be obtained under the assumption that the null hypothesis (e.g. no difference between the population means) is true. A small p-value (e.g. smaller than 0.05) is considered as sufficient evidence that the result is statistically significant. Statistical significance does not necessarily imply that the result is important in practice as these tests have a tendency to yield small p-values (indicating significance) as the sizes of the data sets increase.

3.5.1 Sample size calculation

In this case the researcher did not get a random sample, but was forced to use an availability sample and consider the obtained results as a subpopulation of the target population due to the weak response of the planned random sample. Sometimes data obtained from convenience sampling are erroneously analysed as if they were obtained by random sampling. Convenience data will be considered as small populations for which statistical inference and p-values are not relevant. Instead of only reporting descriptive statistics in these cases, effect sizes can be determined. Practical significance can be understood as a large enough difference to have an effect in practice (Ellis. & Steyn, 2003:51-53.)

A natural way to comment on practical significance is to use the standardised difference between the means of two populations, i.e. the difference between the two means divided by the estimate for standard deviation. We introduce a measure that is called the effect size, which not only makes the difference independent of units and sample size, but relates it also with the spread of the data, see Steyn (1999:53) and Steyn (2000:68).

All calculations have been inserted into Annexure C. The chapter includes the interpretation of the p-values for the sake of completeness, but we have focussed more extensively on effect sizes for interpretation and conclusions.

3.6 Descriptive statistics and frequency analysis

In order to analyse the data collected from participants in the survey we use elements of descriptive statistics such as

- measure of an average value; and
- measure of variability around this average.

It is important to understand each of the above elements for the analysis and interpretation of the data received from participants in the survey.

Apart from the descriptive statistics, frequencies and percentages of the items were also calculated.

The following formulas were used in some calculations for the descriptive statistics:

The measure of an average value can be defined as the mean and is the most common measure of central tendency (Levin, Stephan, Krehbiel & Berson, 2008:97). All the formulas

described below were used in this calculation for the descriptive statistics as well as further analyses.

Mean: If we denote x as the individual numbers of the items of data and n as the number of data items, then the arithmetic mean calculation becomes Equation 3.1:

Equation 3.1: Mean calculation

$$Mean = \frac{\sum x}{n}$$

where $\sum x$ is the sum of all the x values. There are other measures of central tendency that can be calculated for the same set of data. (Levin *et al.*, 2008:99).

The measure of variability around this average can be defined as the standard deviation; this is a far more important and widely used measure of variability (Levin *et al.*, 2008:107). There are two versions of this calculation: one measures the sample standard deviation and the other measures the population standard deviation. The mean formula was used in some calculations in the descriptive statistics section.

Standard deviation (population) is the square root of the sum of the squared differences around the mean divided by the sample size. The formula for calculating the standard deviation is:

Equation 3.2: Standard deviation calculation for population

$$SD = \sqrt{\frac{\sum (x - \bar{x})^2}{n}}$$

Where x refers to the individual data items, $\bar{x}$ is the mean and n the number of data items in the data set. The formula is simply the square root of the sum of the squared deviations divided by the number of items in the data set.

Standard deviation (sample) is the square root of the sum of the squared differences around the mean divided by the sample size minus one. In the context of the sample standard deviation it is also important to note that the formula for its calculation is slightly different from that of the population standard deviation. The formula for calculating the standard deviation is:

Equation 3.3: Standard deviation calculation for sample

$$S = \sqrt{\frac{\sum(x - \bar{x})^2}{n - 1}}$$

The difference is in the divisor in the equation being $n - 1$, not n .

The standard deviation measures the average scatter around the mean; how large values fluctuate above it and how smaller values distribute below it (Levin *et al.*, 2008:106).

The latter formula was used in the study, since a sample was used, not the entire population.

3.6.1 Biographical data

The table below shows the gender spread for all the respondents.

Table 3.2: Biographical data

	Frequency	Percent
Male	26	81.3
Female	6	18.8

The average age of the respondents was 28 years old. The youngest participant was 21 years old, and the oldest participant was 43 years old. We can also see that 81.3% of the respondents were males, and only 18.8% were females. This result is representative of the current ratio in the market since more men are interested in following a software development career than women.

3.6.2 Descriptive statistics interpretation

The rest of the answers to the questions will be interpreted below:

Question 3: Occupation

The table below shows the different occupations of the respondents. We focussed on the software developers, or any similar occupation that is involved in the software development process. There are many different areas within the software development process as can be seen in the table below.

Table 3.3: Occupation

	Frequency	Percent	Valid percent	Cumulative percent
Candidate technician	1	3.1	3.2	3.2
Developer	4	12.5	12.9	16.1
Engineer	3	9.4	9.7	25.8
IM officer	1	3.1	3.2	29.0
IT Administrator	1	3.1	3.2	32.3
IT Manager	1	3.1	3.2	35.5
IT Specialist	1	3.1	3.2	38.7
IT Technician	2	6.3	6.5	45.2
IT Support service	1	3.1	3.2	48.4
Lecturer	2	6.3	6.5	54.8
Programmer	1	3.1	3.2	58.1
Project manager	1	3.1	3.2	61.3
Senior analyst	1	3.1	3.2	64.5
Social worker	1	3.1	3.2	67.7
Software developer	5	15.6	16.1	83.9
Student	5	15.6	16.1	100.0
Total	31	96.9	100.0	

Question 3:

This question focuses on whether an innovative product creates an opportunity for a company to offer its customer something unique. Respondents were asked to indicate whether they agree or not on a Likert scale of 1-4 (1-Not at all; 2 – Somewhat; 3-Agree; 4- Completely agree). From all respondents the mean was calculated to be 3.28, which indicates that most respondents agreed.

Question 4:

Innovation is measured by looking at the bottom-line of the company financials. This question wanted to see whether most participants think that innovation turn knowledge into money. Respondents could only choose Yes/No or Maybe. Not one respondent chose “No”. Most respondents selected “Yes” (65.6%), and the rest of the respondents chose “Maybe” (34.4%). It is clear from these results that most people in the Software Development Industry agree that innovation can have a positive influence on the profit of the organisation.

Question 5:

The terms “innovation” and “invention” were discussed in the literature review, and it was clear that the terms are used interchangeably in the market, although they have two different

meanings. The respondents were asked whether they think the terms “innovation” and “invention” can be used interchangeably. Respondents could only choose Yes/No or Maybe. The results were clear that some confusion exists regarding the use of the two terms, since 40.6% said “No”, and 40.6% said “Yes”, and the remainder of the respondents chose “Maybe” (18.8%). An equal amount of respondents chose “Yes” and “No” which can indicate the uncertainty regarding the two terms in the industry.

Question 6:

A measure was needed to determine to what extent the respondent thinks creativity generates innovation. The mean was calculated for this question and resulted to **3.25**, which means that most respondents agreed with the viewpoint.

Question 7:

We wanted to determine the most influential factor that makes innovation a success. The respondents could choose from a list of four options: Innovative capability; Network sufficiency; Market orientation; Don’t know. They could only choose one option.

Table 3.4: Influential factor

Factor	Percent
Innovative capability	31.3
Network sufficiency	34.4
Market orientation	21.9
Don’t know	12.5

The results are evenly spread among the three influential factors. Network sufficiency resulted in the highest percentage (34.4%), and Innovative capability was the second highest on 31.3%. The literature study indicated that these three factors are very important in order for innovation to be successful, and the results are clear that not one factor is dominant.

Question 8:

The term Business Process Excellence is a relatively new term in the industry. This question simply asked the respondents whether the respondent has ever heard of the term Business Process Excellence. They could either chose “Yes” or “No”. The results confirmed that not many people have heard of the concept “Business Process Excellence” since only 21.9% of the respondents chose “Yes”.

Question 9:

This question determined whether the respondent thinks that businesses will rely more on innovative solutions to improve existing processes. Respondents could only choose Yes/No or Not sure. Just more than half of the respondents indicated that they think business will rely more on innovative solutions (53.1%). A large percentage (31.3%) of respondents also indicated that they are not sure. It can be assumed that not all companies consider the use of innovative solutions for their business, and basically continue the use of the same processes, since a high percentage of the respondents chose option “Not sure” and “No”.

Question 10:

This question simply measured the attitude of the respondent towards the use of Business Process Excellence. The response was largely positive with a percentage of 84.4% of respondents indicating that the approach appeals to them personally.

Question 11:

The importance of exploring new ideas within the software development process was measured in this question. We again see a very large percentage (90.6%) of respondents indicating that they agree that adding an **explore** step in the software development process to explore new ideas and solutions is important.

Question 12:

There exist many definitions for the term, innovation. We gave the respondents four different definitions of innovation, to see whether they agree with the definition that was chosen by the researcher for the study. It was clear that most of the respondents chose the same definition for innovation with a percentage of 71.9%.

Question 13:

Since this study focussed on the improvement of business processes, Question 13 asked the respondent whether the improvement of business processes should include a session where all possibilities to improve the process are explored. Respondents could choose on a scale of 1-4, where 1-Never; 2-Sometimes; 3-Often; 4-Always. The mean was calculated for the result, and amounted to **3.41**. A standard deviation of 0.665 was calculated for this question. This indicated that the respondents chose that more than often the possibility should be considered to improve business processes.

Question 14:

When companies encourage the generation of innovative ideas it is important for them to give the employee the right to fail when trying new things. If an employee were dismissed for trying a new process that failed, employees would be reluctant to try these new ideas again. This question asked the respondent whether he is allowed to fail when trying new ideas. The respondent could choose on a scale of 1-4, where 1-Never; 2-Sometimes; 3-Often; 4-Always. The mean of 2.25 was calculated, and it is clearly much lower than previous questions, and not very positive. Clearly employees are not allowed to fail and learn from their mistakes.

Question 15:

Many of the innovative ideas that come from people, are from people that have a very creative brain, but more than often these people do not want to accept responsibility for their new ideas when implemented. This question asked whether the employee wants to accept responsibility for innovative products and services. The respondent could choose on a scale of 1-4, where 1-Never; 2-Sometimes; 3-Often; 4-Always. The mean of **3.31** was calculated. This was surprisingly high, and indicated that many respondents would take responsibility for their new ideas.

Question 16:

Brainstorming sessions, or sessions that include the exploring of new ideas need to be structured. One also needs to consider every idea that is generated, no matter how impossible or complex the idea sounds. A measurement was done to see whether employees felt that their ideas are considered to be good. The respondent could choose on a scale of 1-4, where 1-Never; 2-Sometimes; 3-Often; 4-Always. The mean of **2.78** was calculated, which indicated that employees feel that their ideas are considered to be good close to often.

Question 17:

As mentioned above, it is important for a company to follow a certain process with regard to thinking of new products or services. The question was asked whether the respondent's company used a certain process or structure for the generation of new ideas or products. The respondent could choose either Yes, No, or Not sure. The results obtained were very close to each other, since 34.4% of respondents chose "Yes", and 31.3% chose "No", and the remaining 34.4% of respondents chose "Not sure".

Question 18:

A centralised repository to collect ideas, or room to test new products or services is essential for an innovative environment. The result from this question confirmed that not many companies have such facilities to encourage an innovative environment. Only **25%** of respondents indicate that they have such facilities, and 62.5% indicated that no such facilities exist within their organisation.

Question 19:

This question evaluated whether the respondent agrees that all innovations should ultimately contribute to the company's bottom line or profits. The respondent could choose either Yes, or No. Since the effectiveness of innovation can be measured by the profits of the company, most (71.9%) respondents indicated that innovation should contribute to the company's overall profit.

Question 20:

This question evaluated whether the implementation of innovative ideas is a critical factor that can increase a company's competitive advantage. The respondent could choose either Yes, or No. From the respondents' viewpoint (93.8%) the implementation of innovative ideas is a critical factor to increase the company's competitive advantage.

Question 21:

Companies should reward their employees when they contribute to new products or services. This question simply evaluated whether the respondents' companies reward their contributing towards new products or services. The respondent could choose either Yes, No, or Not sure. The greatest part of the respondents (**40.6%**) indicated that they are not sure whether their company rewards employees for contributing towards new products or services. The remainder of the respondents said yes and no in almost equal percentages (**Yes – 31.3%; No-28.1%**). An assumption can be made that the majority of companies do not communicate rewards for innovative ideas to the employees, or simply do not reward them for their innovative contributions.

Question 22:

An innovative environment is encouraged by the company towards the employees. This question asked the respondents whether an innovative environment is encouraged within the workplace. The respondent could choose either Yes or No. Most respondents (**65.6%**) indicated that an innovative environment is encouraged within the workplace; the remainder of the respondents indicated that an innovative environment is not encouraged.

Question 23:

Management should communicate the company strategy to all levels within the organisation in order to allow employees to be actively involved in reaching their goals. Respondents were asked whether management does perform this function. The respondent could choose either Yes or No. Most respondents (**65.6%**) indicated that management does communicate the company strategy. This is the same percentage that was obtained in Question 22. It can be derived that the company strategy is communicated together with the innovative encouragement.

Question 24:

The reason for this question was to evaluate the computer literacy of the respondent. Since most software developers are expected to be very computer literate, it was interesting to see how they rate themselves. The respondent could choose on a scale of 1-4, where 1-No knowledge; 2-Beginner; 3-Intermediate; 4-Advanced. The mean was calculated for the result, and equalled to **3.5**. This is quite high as expected, and also confirms that most software developers rate themselves to be advanced computer users.

Question 25:

This question evaluated whether the implementation of innovative ideas can increase a company's competitive advantage. The respondent could choose on a scale of 1-4, where 1-Not at all; 2-Somewhat; 3-Average growth; 4-Absolutely. The mean was calculated for the result, and equalled to **3.44**, with a standard deviation of 0.716. From these values it is clear that most respondents felt that a company can increase its competitive advantage by implementing innovative ideas.

Question 26:

A perception from most companies could be that an innovative idea causes a complete turnaround within a company's structure and strategy. We asked the respondents whether they think improved performance can be achieved through continuous big or small innovative ideas. Respondents had to choose only one option: big or small, and resulted in **71.9%** of respondents indicating that they think small innovative ideas can make a big difference with regard to the improvement of the company's performance.

Question 27:

Software development projects fail due to some unforeseen factors. The respondents were asked to indicate by percentage which failure occur the most. The aggregated percentages are given in the table below.

Table 3.5: Project failures

Failure type	Mean	Std. deviation
Never completed	14.16	11.745
Operational / Over budget	22.03	15.126
Over the time estimate	34.84	18.556
Completed with fewer specifications	29.28	21.169

We can derive from Table3.4 that most projects fail due to running over the time estimate. When software companies are then forced to release a software version on a specified date, the company will release the software but with fewer specifications. This type of project failure was indicated to be the second biggest reason why projects fail.

Question 28:

We investigated the utility of pair programming in the literature study. Respondents were asked whether they think that development time would increase or decrease when this type of programming utility is used. The respondent could choose on a scale of 1-3, where 1-Not at all; 2-Moderately; 3-Strong increase. The mean was calculated for the result, and equalled **2.28**, with a standard deviation of 0.683. The mean value of 2.28 indicated that respondents feel that the time would increase moderately. The literature suggests that the programming time would decrease since developers would be able to share solutions, instead of having to solve all the problems themselves. It is also true that when two developers would be working on one problem, instead of one developer fixing one problem, it can cause development time to increase. The efficiency depends on how well the two developers would be working together, and what process they would follow in solving the problems.

Question 29:

Software development remains a complex task for various reasons. We gave respondents the three biggest reasons why software development remains a complex task and asked them to rank them according to their complexity. The three reasons were:

1. System failures
2. Project overrun
3. Unfinished projects

The table below shows the results for the respondents.

Table 3.6: Reasons why software development remains a complex task

	Mean	Std. deviation
System failures	2.06	.564
Project overrun	1.44	.759
Unfinished projects	2.50	.762

Question 30:

The respondent was asked to what extent the respondent's company promotes organisational learning to enhance knowledge that can be utilised in the future. The respondent was asked to rate his/her answer from 1-3, where 1-Not at all; 2-Moderately; 3-Strongly. We calculated the mean for this question and the result was equal to **2.16**, with a standard deviation of 0.574. From the results we can see that most companies have a moderate response towards company learning and gaining knowledge that can be utilised for the company's future.

Question 31:

The result for the question was not included in the frequency analysis, and will be discussed later in the document.

Question 32:

The respondent was asked to what extent he/she agrees that as the complexity of the software grows, end users demand enhanced service, and zero downtime. The respondent was asked to rate his/her answer from 1-3, where 1-Not at all; 2-Moderately; 3-Strongly. We calculated the mean for this question and the result was equal to **2.53**, with a standard deviation of 0.507. The mean result indicated that most respondents indicated a moderate to strong feeling towards enhanced service, and zero downtime as the complexity of the software grows.

Question 33:

This question asked the respondent whether the current development process includes the measurement of reliability or productivity. The majority of respondents (**53.1%**) responded that they do include a measurement of reliability or productivity in their development process. A further 37.5% of respondents were not sure.

Question 34:

The respondent was asked whether he/she thinks that a small improvement in the software development process can result in a significant improvement in the quality of the software developed. The respondent was asked to rate his/her answer from 1-3, where 1-Not at all; 2-Yes; 3-Not sure. The majority of respondents (**81.3%**) agreed that a small improvement in the software development process can result in a significant improvement in the quality of the software developed. A small 18.8% indicated that they were not sure.

Question 35:

This question asked the respondent whether the current development process enables them to detect defects in the software in the early stages of development even before testing commences. The respondent was asked to rate his/her answer from 1-3, where 1-Not at all; 2-Yes; 3-Not sure. More than half of respondents (**53.1%**) indicated that the software development process does enable them to detect defects early in the stages of development. A small percentage of 34.4% was not sure.

Question 36:

The respondent was asked whether he/she considers that a step-by-step process is needed to measure the product quality. The respondent was asked to rate his/her answer from 1-3, where 1-Not at all; 2-Yes; 3-Not sure. It is clear that the majority (**81.3%**) of respondents agreed that a step-by-step process is needed to measure the product quality.

Question 37:

This question asked the respondent whether a proactive rather than a reactive approach to software development would decrease the defects found in software development. The respondent was asked to rate his/her answer from 1-3, where 1-Not at all; 2-Yes; 3-Not sure. The result from the percentages indicates that **71.9%** of respondents chose option 1-Not at all. The researcher was led to think that the majority of respondents would choose option 2-Yes, since being proactive, and solving problems before they happen could save time in the later stages of the software development process. However, the result was clear, and this finding will be incorporated in the next Chapter.

Question 38:

In this question the respondent was able to choose more than one answer from the list. We asked the respondent to indicate which of the listed methods his/her company uses to add value for their customers.

The table below shows the result from the respondents.

Table 3.7: Methods to add value for customers

	Times occurred
Enhancing processes	21
Enhancing products	17
Using innovation	11

Table 3.6 indicated that enhancing the processes of the company can add the most value for customers. Secondly, if the company enhances its products, it would also add value for customers. We need also to remember that all three these methods are important to add value for customers, but the question aimed at which one of the methods would be used most often. Since innovation is still a relatively new concept we can see that this option was selected the least number of times.

Question 39:

This question asked the respondent whether a reduction in input can produce more output. The respondent was asked to rate his/her answer from 1-3, where 1-Not at all; 2-Yes; 3-Not sure. The result from the percentages indicates that the respondents had a difficult time in deciding on this question. The percentages were quite evenly spread out.

- Not at all – 28.1%
- Yes – 31.3%
- Not sure – 40.6%

The majority of respondents were not sure, and then the second biggest percentage (31.3%) indicated that reduction in input can produce more output.

Question 40:

This question asked the respondent whether the importance of measuring productivity can be denied in an organisation. The respondent was asked to rate his/her answer from 1-3, where 1-Not at all; 2-Yes; 3-Not sure. Most respondents (**46.9%**) indicated that the

importance of measuring productivity cannot be denied in an organisation. A remaining percentage of 37.5% of the respondents were not sure.

Question 41:

This question asked the respondent whether each process manager in the organisation accepts responsibility for the steps involved in the software development process. The question was aimed at whether the manager takes ownership for the actions. The respondent was asked to rate his/her answer from 1-3, where 1-Not at all; 2-Yes; 3-Not sure. More than half of the respondent (**56.3%**) indicated that each process manager in the organisation accepts responsibility for the steps involved in the software development process. A remaining percentage of 31.3% of the respondents were not sure.

Question 42:

This question asked the respondent whether his/her company uses the Deming Circle model to increase the quality of their processes. The respondent was asked to rate his/her answer from 1-3, where 1-Not at all; 2-Yes; 3-Not sure. The majority of the respondents (68.8%) were unsure. Only a small percentage (18.8%) of the respondents indicated that they do use the Deming Circle.

3.7 Further analysis

In the section we have created some relationships between certain questions from the questionnaire, and performed some advanced statistical analysis on the results.

3.7.1 Cross-tabulation for Question 4 and Question 7

A cross-tabulation was used to determine whether there was a relationship between Questions 4 and 7. This method is used to determine relationships between two categorical variables.

Table 3.8: Cross-tabulation (Q4 vs. Q7)

		Question 7				
			Innovative capability	Network sufficiency	Market orientation	Don't know
Question 4	Maybe	Count	3	2	4	2
		% within Q4	27.3%	18.2%	36.4%	18.2%
	Yes	Count	7	9	3	2
		% within Q4	33.3%	42.9%	14.3%	9.5%

Question 4 evaluated whether most participants think that innovation turns knowledge into money. Question 7 determined the most influential factor that makes innovation a success. With the combination of the two questions we wanted to establish whether we can identify a success factor that can ultimately contribute most to the profitable innovative factor.

From the cross-tabulation we can see that for the respondents that answered “Maybe”, the most influential factor was “Market orientation” with 36.4%. From the respondents that answered “Yes” to Question 4, 42.9% of respondents chose “Network sufficiency” as the most influential factor. The order of the most influential factor changed depending on whether the respondent said “Yes” or “Maybe” to Question 4, but in both cases the “Innovative capability” factor was ranked second highest, which indicated that it still needs to be considered as an important influential factor to ensure that innovation remains profitable.

The Chi-square test was performed to determine whether the two questions are interdependent. The Chi-square p-value needs to be smaller than a predetermined level of significance (0.05 for a 5% significance level) for the relationship to be statistically significant. In this case the p-value is larger than 0.05 (0.33), which indicates that there is no statistically significant dependence between Question 4 and Question 7. Although the statistics indicate that the most chosen success factor to enhance innovation does not influence whether knowledge will be turned into the money, we know that successful implementation of innovative ideas does have a positive influence on the bottom-line of the company,

We then consider the effect size for determining the dependence between two categorical variables, which is the Phi-value. Phi can be interpreted as follows:

If $\Phi = 0.1$ then we have small effect with no practically significant dependence

If $\Phi = 0.3$ then we have a medium effect with practical visible dependence.

If $\Phi = 0.5$ then we have a large effect with practically significant dependence

(Steyn, 2002:10-15)

We can see from the calculations in Annexure C that the Phi value was calculated at 0.326 which indicates that we have a medium effect with practical visible dependence. This result emphasises our thinking that if companies would enhance innovation they would probably be able to turn knowledge into money.

3.7.2 Independent t-test and Cohen's d-value for Question 22 and Question 27

We used the independent T-test for this evaluation. Question 22 asked the respondents whether an innovative environment is encouraged within their workplace. They could only choose "Yes" or "No". Question 27 showed the reasons why software development projects fail, and asked participants to rank them by giving the percentage of problems that can be ascribed to that failure. We wanted to establish whether there is a relation between a workplace that encourages an innovative environment and a workplace that doesn't, to see if they experience different reasons for software development project failures.

The failures included:

1. Never completed (Q27_1)
2. Operational / Over budget (Q27_2)
3. Over the time estimate (Q27_3)
4. Completed with fewer specifications (Q27_4)

Table 3.9: T-Test for Question 22 and Question 27

	Mean% (Yes)	Mean% (No)	p	Std.dev. (Yes)	Std.dev. (No)	Effect sizes
Q27_1	14.90	12.73	0.63	13.27	8.47	0.16
Q27_2	21.67	22.73	0.85	13.26	18.89	0.06
Q27_3	37.86	29.09	0.21	20.53	13.00	0.43
Q27_4	26.05	35.45	0.24	19.01	24.54	0.38

We can also see from the table above that the p-value is larger than 0.05, which indicates that the two variables are not statistically significant. Since we cannot actually use the p-value in the context of an availability sample, the effect size needs to be calculated and interpreted. We will use Cohen's d-value.

This effect size is calculated as the proportion of the variation accounted for by the regression line relative to the proportion not accounted for:

$$f^2 = \frac{R^2}{1 - R^2}$$

Cohen's d-values are categorised in the following ranges:

If d = 0.2 then we have small effect with no practically significant difference

If d = **0.5** then we have a medium effect with practical visible difference

If d = 0.8 then we have a large effect with practically significant difference

The table above showed that the effect size for Question 27_3 was almost 0.5 (**0.43**) which means that we have a medium practically significant difference for this option in the question. It is indicated that the group who answered Yes to Question 22 (indicating the encouragement of an innovative environment) assigned a higher mean percentage to “Over the time estimate” failures than respondents who answered “No” to Question 22.

The rankings were also compared for the Yes and No answers. For all respondents that chose “Yes”, we can see that the reason “Over the time estimate” scored the highest percentage. Reason “Completed with fewer specifications” was ranked as second largest percentage, with “Operational / Over budget”, and “Never completed” ranking third and fourth respectively.

For all respondents that chose “No”, it can be deducted that the reason “Completed with fewer specifications” scored the highest percentage. Reason “Over the time estimate” was ranked as second largest percentage, with “Operational / Over budget”, and “Never completed” ranking third and fourth respectively.

3.7.3 Cross-tabulation to compare method “Enhancing processes” in Question 38 to add value for customers to Question 9

In Question 9 the aim was to see whether respondents think businesses will rely more on innovative solutions to improve existing processes. We aimed to see whether respondents who said “Yes” also chose the method “Enhancing processes” to add value to customer in Question 38.

A cross-tabulation was used to determine whether there was a relationship between Question 38_1 and Question 7. This method is used to determine relationships between two categorical variables.

Table 3.10: Cross-tabulation for Question 38_1 and Question 9

			Question 9		
			Yes	No	Not sure
Question 38_1	No	Count	5	2	4
		% within Q38_1	45.5%	18.2%	36.4%
	Yes	Count	12	3	6
		% within Q38_1	57.1%	14.3%	28.6%

We can observe from the table above that of the people who said that Enhancing processes will add value in Question 38, **57.1%** of respondents were those that said “Yes” in Question 9.

The Chi-square test was performed to determine whether the two questions are dependent. The Chi-square p -value needs to be smaller than some predetermined level of significance (0.05 for a 5% significance level) for the relationship to be statistically significant. In this case the p -value is larger than 0.05 (0.82, which indicates that there is no statistically significant dependence between Question 4 and Question 7.

We then consider the effect size for determining the dependence between two categorical variables, which is the Phi-value. We can see from the calculations in Annexure C that the Phi value was calculated at 0.111 which indicates that we have a small effect with no practically significant dependence.

A Pearson Chi-square test was also performed to determine the p -value for the relationship. The p -value was calculated at 0.820 which is larger than 0.05 and indicates that the two variables are independent.

3.7.4 Independent T-test and Cohen’s d-value for Question 38_2 “Enhancing products” and Questions 27 and 16

The independent T-test was used to compare the mean scores on Question 14 and Question 16 of respondents who respectively ticked and did not tick “Enhancing products” in question 38. Question 14 asked the respondent whether he is allowed to fail when trying new ideas. Question 16 measured whether employees felt that their ideas are considered to be good.

Table 3.11: T-test Questions 14 and 16 compared to Question 38_2

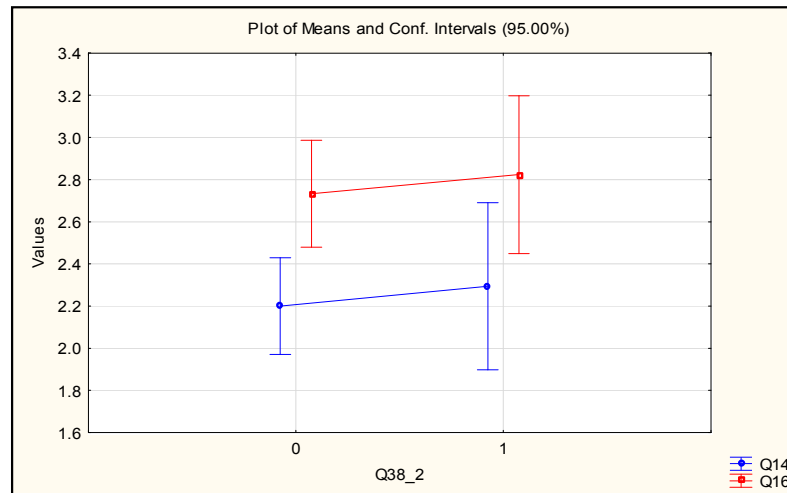
	Mean (Yes)	Mean (No)	p	Std.dev. (Yes)	Std.dev. (No)	Effect sizes
Q14	2.29	2.20	0.68	0.77	0.41	0.12
Q16	2.82	2.73	0.68	0.73	0.46	0.12

From the table above we can make the following analysis. We can see the p -value is larger than 0.05, which indicates that there is no statistically significant difference.

The effect sizes on both Question 14 and Question 16 are below 0.2 which results in small effect with no practically significant dependence.

The figure below is an illustration of the differences between Question 14 and Question 16.

Figure 3.2: T-test Questions 14 and 16 compared to Question 38_2



It can be derived from the graph that neither Question 14 nor Question 16 shows great differences from Question 38 between the two groups. Since we cannot use the p -value for further analysis, we will use Cohen's d -value. The effect size on both Question 14 and Question 16 is below 0.2 which results in small effect with no practically significant dependence.

3.7.5 Cross-tabulation to compare method "Using innovation" to Question 22.

Question 22 asked the respondents whether an innovative environment is encouraged within their workplace. We then compared the results to the results of respondents who respectively ticked and did not tick "Enhancing products" in question 38. We used the Cross-tabulation method.

Table 3.12: Cross-tabulation for Question 22 and Question 38 3

		Question 22		Total	
		Yes	No		
Question 38_3	No	Count	14	7	21
		% within Q38_3	66.7%	33.3%	100.0%
	Yes	Count	7	4	11
		% within Q38_3	63.6%	36.4%	100.0%

The table shows those respondents that did select the method to use innovation to add value to customers. 63.6% of those respondents also said "Yes" in question 22 (their workplace does encourage an innovative environment). We also notice that 66.7% of

respondents who did not select the method to use innovation to add value to customers also said “yes” to question22.

The p-value was calculated at 0.820 which is larger than 0.05 and indicates that the two variables are independent.

3.7.6 Correlation between Question 14 vs. Question 16

Question 14 asked the respondent whether he/she is allowed to fail when trying new ideas. Question 16 measured whether employees felt that their ideas are considered to be good by fellow employees and their superiors. The reason for performing further analysis on these two questions is to establish whether there is a linear relationship between an employee experiencing that he is allowed to fail and how their ideas are regarded by fellow employees.

The Pearson’s correlation coefficient (r) was calculated as follows:

Pearson's correlation coefficient between two variables is defined as the covariance of the two variables divided by the product of their standard deviations (Rodgers & Nicewander, 1988:23)

$$\rho_{X,Y} = \frac{\text{cov}(X, Y)}{\sigma_X \sigma_Y} = \frac{E[(X - \mu_X)(Y - \mu_Y)]}{\sigma_X \sigma_Y},$$

The above formula defines the population correlation coefficient, commonly represented by the Greek letter ρ (rho). Substituting estimates of the covariances and variances based on a sample gives the sample correlation coefficient, commonly denoted r :

$$r = \frac{\sum_{i=1}^n (X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum_{i=1}^n (X_i - \bar{X})^2} \sqrt{\sum_{i=1}^n (Y_i - \bar{Y})^2}}.$$

If $r = 0.1$ then we have small effect with no practically significant correlation

If $r = 0.3$ then we have a medium effect with practical visible correlation

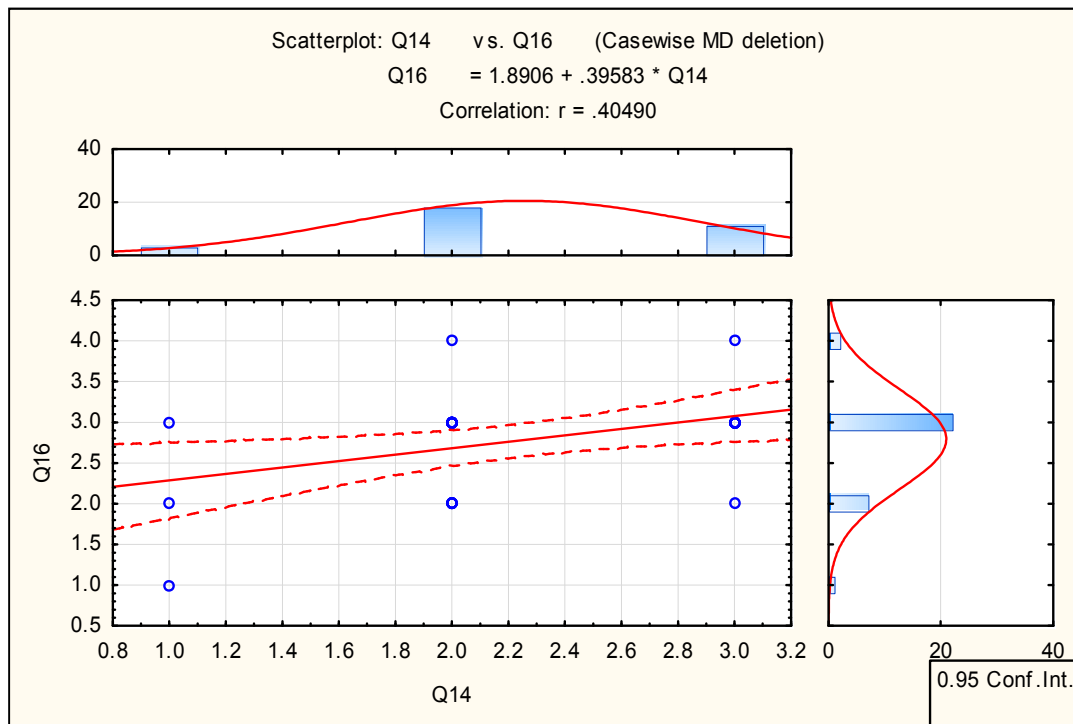
If $r = 0.5$ then we have a large effect with practically significant correlation

Table 3.13: Pearson’s r for Question 14 and Question 16

	Q14	Q16
Question 14	1.00	0.40
Question 16	0.40	1.00

The table above shows that we have a medium to large effect with practical visible correlation for both Question 14 and Question 16.

Figure 3.3: Scatterplot and linear relation for Question 14 and Question16



From the above graph it can be observed that a positive linear relationship (when one variable increases then the other one increases as well) exists between Question 14 and Question 16. We can hereby confirm that the more the respondents feel that their ideas are being considered to be good and valuable, their effort in trying to implement their ideas will increase, even if it means that they are not allowed to fail.

3.7.7 ANOVA comparison for Question 15 and Question 21

Question 15 focussed on whether people want to accept responsibility for their new ideas when implemented. Question 21 simply evaluated whether the respondents' company reward them for contributing towards new products or services. Questions 15 gave the respondents the option to choose on a Likert scale from 1-4, where 1-Never; 2-Sometimes; 3-Often; 4-Always. Question 21 only has "Yes", "No", or "Not sure" options for the respondent.

A comparison was done to see whether rewarding people would encourage employees to accept responsibility for their innovative ideas. All calculations can be retrieved from Annexure C. We used an ANOVA test to compare the means of different groups.

An Omnibus test was conducted to test if there are any differences. Post hoc tests were then conducted to determine pair-wise if any of the groups differ. The p-value was equal to 0.56 which is larger than 0.05, which indicates that no statistically significant difference exists.

Table 3.14: Omnibus tests

	SS	df	MS	SS	df	MS	F	p
Q15	0.509188	2	0.254594	12.36581	29	0.426407	0.597068	0.56

Post hoc tests were then conducted to determine pair-wise if any of the groups differ.

Table 3.15: P-values for the post hoc tests

p-values		{1}	{2}	{3}
1	{1}		0.62	1.00
2	{2}	0.62		0.65
3	{3}	1.00	0.65	

Table 3.16: Effect sizes for the post hoc tests

Effect sizes		{1}	{2}	{3}
1	{1}			
2	{2}	0.37		
3	{3}	0.02	0.35	

The tables above show the effect sizes for ANOVA in comparison with Question 15 and Question 21. It can also be observed that the effect sizes are all small which means no practically significant effect was found.

3.8 Qualitative analysis results

A qualitative analysis was also completed since we received two completed questionnaires from the general managers of each software development division. The two completed questionnaires were received from Mineware, and DCD-Dorbyl.

The first question asked the respondent how his/her department creates new products or services through innovation. The response ranged from current research and development approaches to simply fulfilling customer needs. It was clear that these companies had no specific structure with regard to the innovation process, and generating innovative products and services.

Secondly we asked the respondents why they think their company requires innovation. Both respondents explained the need for sustainable competitive advantage. Companies need to be competitive in the market to survive.

The third question asked the respondents which trusted process is used to implement their innovative strategy. The respondents explained that the reinvention of the current strategy concept was used. This is very similar to the process of Business Process Excellence, since Business Process Excellence uses an explore step to evaluate all possibilities to reinvent the current system in order to create innovative strategies and products. Another approach that was mentioned by the respondents was to have regular user-group meetings to receive feedback from the users with regard to their needs. This approach is similar to a brainstorming session where all creative ideas can be collected and processed to create an innovative strategy.

The next question asked the respondent to explain the current software development process. Both respondents had a structure process that was followed. The process was tailor-made to fit their needs and specifications. This confirms that most software development companies do have a software development process in place, but the process is seldom changed or reinvented to accommodate innovative ideas and exploration for possible solutions.

Question 5 asked the respondent whether they agree that Web-enabled social creativity environments can support innovative approaches to software development. Both participants agreed, but some thought was given with regard to offering something to customers that is unique, since sharing these ideas on a social platform would mean that everyone could use the idea, and simply offer their users what other companies are also offering.

Question 6 asked the respondent whether he/she sees their users as creators, and whether they consult with the users regarding open systems and feature selections. Both respondents agreed that users add extensively to generating innovative ideas, and that they definitely view their users as creators.

In the next question the respondent was asked to what extent he/she agrees that as the complexity of the software grows, end users demand enhanced service and zero downtime. Both agreed, and explained that this is especially important in an environment where users are not always used to the latest technology.

The second last question asked the respondent which steps of the software development process he/she thinks should be measured for reliability, and how they measure productivity.

An overall test is conducted to see whether the solution meets the customer's need and satisfies his/her specifications. Another approach that was mentioned was to simply compare the specification time with the actual time taken to develop the function. From the response it seems that the measurement for productivity is not structured and complete, and could need more attention.

The last question asked the respondents which model they use to increase the quality of their processes, and whether they use the Deming Circle as a basis. Not one of the respondents used the Deming Circle. Performance of the developers was weighed against their abilities, and benchmarked according to a coding system. Another approach included suggestion boxes, and performance enhancement schemes.

3.9 Conclusion

The analysis of this chapter included both a quantitative as well as qualitative analysis. Both these analyses reported a positive result for the use of Business Process Excellence in the software development industry. Most respondents indicated that the use of Business Process Excellence appeals to them personally, and that they think that their organisations can benefit from this process. Employees feel that they should be given the right to fail when trying new things that could benefit the company; otherwise a resistance to trying new ideas would destroy the innovative environment.

Most software development employees are skilled workers with great knowledge and innovative capabilities. Companies should never underestimate the skills level of their employees, and also encourage organisational learning that could contribute to future innovations.

The results also indicated quite a low implementation rate for innovation within the organisation. Improved performance can be achieved through continuous small innovative ideas. Many companies still do not encourage an innovative environment, and also do not reward the employees for their innovative contributions. Businesses will have to rely more heavily on innovative solutions to improve existing processes, and increase their sustainable competitive advantage. End users demand enhanced service and zero downtime as the complexity of the software grows. An innovative environment should be encouraged from the company towards the employees. Management should communicate the company strategy to all levels within the organisation in order to allow employees to be actively involved in reaching their goals

A factor that should consider most attention by organisations is the increasing of network sufficiency in order to ensure successful innovation. Innovative capability should not be neglected, since this contributes to the success factor. Software development companies should explore new ideas within the software development process. It is important that when these possibilities are explored, all possibilities should be considered for implementation.

All innovations aim to contribute to the companies' bottom-line, and will also empower companies to offer their customer unique products and services.

3.10 Summary

The result of this chapter identified some key aspects that companies could focus on to encourage an innovative environment. Most employees are willing to accept responsibility for the innovative ideas, since this will benefit the company. Managers should take responsibility for their actions within the software development department, and reward employees that assist in reaching the goals set in company strategy.

The software development process should always include a step for quality and reliability. This step is needed, since even the most innovative product needs to be stable and reliable, otherwise the product will not be used by customers if they are frustrated.

CHAPTER 4 – CONCLUSIONS, INTERPRETATIONS AND RECOMMENDATIONS

In this chapter we give meaning to the results partly by tying them to past theory and practice, and partly by extrapolating them to future theory, research, policy and practice.

4.1 Introduction

The study identified the problem that software development companies do not use innovative processes to generate unique products for their customers in order to create shareholder wealth. By enhancing innovation processes, software development companies can increase their sustainable competitive advantage. Since the term Business Processes Excellence is a relatively new concept, not many results have been published on the use of this process. Therefore this study has focussed on determining the benefits for using Business Process Excellence in a software development environment.

This chapter confirms whether software development companies use predefined processes to implement new products and services. Most software development companies do have existing processes, and have been using them for many years. These processes need to be reviewed and should accommodate a more innovative approach. Software development companies that encourage an innovative process generate innovative products that offer their customers something unique.

Innovative products can increase the company's sustainable competitive advantage, and also contribute to the company's bottom-line. Business Process Excellence can assist companies to eliminate the struggle to complete projects on time and within budget successfully. Business Process Excellence focuses on creating innovative products that satisfy the demand in the market.

4.2 Conclusions

The results of the study are interpreted in light of the full set of results in this section. The limitations, applicable literature and theoretical foundation are also interpreted. The study suggests that innovation in software development can be enhanced when Business Process Excellence is used in the software development process. Business Process Excellence promotes innovative thinking, and possibility to explore new ideas for unique products and services.

It appears that most employees have a positive attitude towards working with management to achieve the goals set in their innovative strategy. There exists a need for employees to

change their mindset in order to enhance product quality and reliability. The results do not indicate whether all companies will be successful in delivering innovative products and services when they use the concept of Business Process Excellence. However, if Business Process Excellence is implemented successfully, the possibility exists for companies to increase their sustainable competitive advantage over the competitors, and turn knowledge into money. The measurement for successful innovation is normally compared to the profits or bottom-line of the company. The survey confirmed that most companies have not heard of the concept Business Process Excellence. The opinions of respondents indicated that the use of BPE can benefit the organisation, and increase the company's market share when the software development organisation has adopted a structured environment for innovative product creation.

The term, innovation, is often confused with the term, invention, and even the respondents indicated that the two terms could be used interchangeably. The definition that was chosen by the largest percentage of respondents for innovation was by Rogers, (1995:11) that states "Innovation is an idea, practice or object that is perceived as new by an individual or other unit of adoption". This definition was also used in literature study by the researcher.

Innovative capability assists in innovation success by providing interaction between customers and environment-related products that will be developed (Meeus & Oerlamans, 2000:87). The interview results also confirm that management uses the interaction between users and the developers to generate new ideas and ways to implement solutions to identified problems. The literature states that network sufficiency is one of the main characteristics of innovative capability, and is the most affecting factor of innovation success (Ritter & Gemünden, 2002:71). Respondents rated network sufficiency the highest percentage (34.4%). This indicates that there is a lack of adequate researches related with innovative capability, market orientation and innovation strategy of software firms in the literature. An innovative strategy increases the overall performance of the company rapidly, and contributes to the sustainable competitive advantage.

Most young people in South Africa are more technologically advanced than the Generation X population for instance, and the concept of *software development* is no strange environment for them (Van Zyl, 2011:13). We could see that the average age for respondents was 28 years old, which confirms that most young people are more familiar with computer terminology than previous generations of the population. Software development companies should employ young, innovative people that have a natural tendency towards the idea of change and innovation in the company.

An interesting discovery was made, namely, that, in order for companies to create growth, sustain performance and develop performance in such a dynamic and changing environment, one way is to make innovations (Patel, 1999; Cottam *et al.*, 2001:4). From the survey and questionnaires respondents indicated that, in order for a company to remain the market leader, it has to implement structured processes to ensure that these innovative ideas are implemented.

Innovation does not imply changing the organisation as a whole in one day; it rather encourages small, incremental innovations to add value to the company's innovative products. Research indicates that: many established organisations achieve improved performance through continuous, small, incremental innovations (Gluck, 1985:413-424) and that incremental innovations are preferred by most established organisations as these are easier to implement within the operational constraints of the organisation (Mezias & Glynn, 1993:42). The survey also confirmed this with most respondents (71.9%), indicating that they think small innovative ideas can make a big difference with regard to the improvement of the company's performance.

The development of software is a complex task, frequently resulting in unfinished projects, project overruns and system failures. We can derive from the survey results that most projects fail due to running over the time estimate. When software companies are then forced to release a software version on a specified date, the company will release the software, but with fewer specifications. To achieve continuous improvement, firms must promote organisational learning to enhance knowledge that can be utilised in the future (Baker & Sinkula, 1999:425). From the result from the respondents we can see that most companies have a moderate response towards company learning and gaining knowledge that can be utilised for the company's future.

Once this increase in productivity is reached, and the innovative products are being implemented, we need to ensure that the quality and reliability of the product is high. A product can be extremely innovative and create a huge demand in the market, but if the consumer or customer finds that it causes more frustration due to malfunction and error, then even the most innovative product will become obsolete.

Business Process Excellence can be used to recognise deviations quickly, and correct them with appropriate measures, or even predict potential errors. Excellent processes connect management, employees, external partners and customers at different locations. The process is also highly flexible so that it can be adjusted rapidly to suit changing market or environmental conditions. This is how businesses create a basis for realising new business

models quickly and even integrate third-party suppliers into their own value chain efficiently. Business Process Excellence (BPE) has a more positive approach to improve a business process ultimately. The response from candidates was largely positive with a percentage of **84.4%** of respondents indicating that the approach appeals to them personally. To achieve continuous improvement, firms must promote organisational learning to enhance knowledge that can be utilised in the future (Baker & Sinkula, 1999: 425).

General managers, who conceive of their customers as creators rather than merely users or consumers, are already changing their requirements analysis, feature selections, and marketing strategies. The interview results also indicated that many software companies use the feedback from their customers to generate new functionality, and products.

The fundamental problem with the SDP is that defects found in the testing phase occur in one or more of the earlier phases, but there is no genuine attempt to address defect elimination early in the process. What is needed is a structured process that ensures the satisfying of basic objectives of each step, and detection and elimination of the root causes of the problems before moving to the next step. The lack of such a structured process to identify the root causes is a fundamental problem with current software development practices (Cockburn & Highsmith, 2001:131-133). It is wise to use a process that produces an output that can be effectively measured at every step of the way. The majority of respondents (**53.1%**) responded that they do include a measurement of reliability or productivity in their development process. A further 37.5% of respondents were not sure.

SD is practised in a reactive, rather than a proactive manner and this is the fundamental limitation of the process (Nidumolu & Subramanian, 2004:159–196). The result of the percentages indicates that **71.9%** of respondents indicated that a reactive approach is preferred. This confirms the literature statement indicating that software development is practised in a reactive rather than a proactive manner. However, being proactive and solving problems before they happen could save time in the later stages of the software development process.

4.3 Recommendations

In this section we recommend practical business processes that can be used to create innovative products and services to add value for customers, and create shareholder wealth.

- Organisations should reward employees that contribute to the implementation of innovative products and services. The rewards may include promotions, bonuses or even commissions that are calculated according to the profits that were generated from the innovative products.

- Employees should also be encouraged to accept responsibility for their innovative products and services.
- The importance of software development companies to employ young, innovative people that have a natural tendency towards the idea of change and innovation on the company should not be underestimated. An innovative company cannot be afraid of change, and be stuck on “old” ways; the company should be flexible.
- An innovative company should implement a learning environment that promotes innovation. Employees should be given the right to fail and learn from their mistakes.
- Companies need to create an innovative environment for their employees. Give employees opportunities to share their innovative ideas, and be encouraged to participate in idea generation sessions.
- Spread responsibility for innovation throughout the organisation.
- Develop partnerships with other departments and create a central repository for ideas and experiments.

More research is needed to be done on the concept of Business Process Excellence, and more companies should adopt the practice in order to generate feedback to how the process enhances innovative thinking.

Software development companies should also create structured procedures to implement innovative ideas and products.

Business Process Excellence can potentially enhance innovative products and services within software development companies once the structured processes are in place to guide and ensure successful implementation of those ideas.

4.4 Summary

The study focussed on the software development environment, and researched whether the industry is primarily driven by structured processes. The survey confirmed that most developers follow these processes with neither room for exploration of new ideas, nor innovative ways of creating value-added products for customers.

Another problem that was addressed was that most software products that are distributed are products that have been requested by customers, and functionality that has been requested by the users. The developers of these products do not create these functions based on innovative ideas within the software development company. Most innovative ideas generated are initially seen as meaningless, and impossible to implement. Once these ideas

are studied and explored for possible implementation a great new innovative product can be developed, and can lead to a new technology in the market.

The possibility of using Business Process Excellence in a software development environment was investigated. The outcomes were identified to create innovation and new ideas for products that will add value for the customer, and also for the organisations' shareholders. The problem was that some organisations do not use these techniques, some seldom use them, and others report unsuccessful implementation and managing of quality assurance programmes. Since BPE is mostly used to optimise production processes to increase productivity and efficiency, we used the framework in a software development environment, and adapted the framework to create innovation in the process.

A literature study was performed to research the different aspects of innovation and BPE, with emphasis on the software development environment. An investigation was executed to see whether these elements can be linked, in order to assist organisations in developing new products and solutions for their customer and creating shareholder wealth. Most companies do not follow the process of Business Process Excellence to create new products and solutions through innovation. Most respondents, however, had a positive attitude towards the use of BPE to encourage innovation within their organisations. Many software organisations already use a structured environment to create innovative products, and would simply need to adapt to the concept of Business Process Excellence.

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ANNEXURE A

Enhancing Innovation in Software Development Using Business Processes

- Interview -

Thank you for agreeing to be interviewed for the purposes of this study. All your answers are confidential and no personal information is required.

This study will assist us in determining the benefits that BPE (Business Process Excellence) creates for the software development industry, since little research has been published on the topic of BPE, and innovation. The reason for the lack of research on BPE is because BPE is a newly used term that has only been in use since June 2010, and the innovation has not been the core focus of many organisations in the last 20 years. Once the innovative environment had been established within companies, we investigate how the innovative ideas and processes can be used to implement new products and services to customers, and create shareholder wealth.

If you wish to receive feedback regarding the results of this survey, please supply your e-mail address below:

E-mail: _____@_____

If you have any queries please contact:

Researcher: Rayno J. Hattingh – raynohattingh@gmail.com

Please provide the following information regarding yourself:

1. Age:

1	
---	--

3. Occupation: _____

2. Gender:

1	Male
2	Female

1. How do you create new products or service through innovation?

2. For what reasons does your company require innovation?

3. What trusted process do you use to implement your innovative strategy?

4. Explain the steps you follow in your Software Development

5. Do you agree that Web-enabled social creativity environments can support innovative approaches to Software Development.

6. Do you see your users (Customers) as creators? Do you consult with them regarding open systems, and feature selections?

7. To what extent do you agree that as the complexity of the software grows, end users demand enhanced service and zero downtime?

8. Which steps of the Software Development process do you think should be measured for reliability. How to measure productivity?

9. What model do you use to increase the quality of your processes? Do you use the Deming Circle?

Thank you for your participation!

ANNEXURE B

Enhancing innovation in software development using business processes

- Research survey -

Dear Respondent,

Thank you for completing this survey. The survey will take approx **15min** to complete. All your answers are confidential and no personal information is required.

This study will assist us in determining the benefits that BPE (Business Process Excellence) creates for the software development industry, since little research has been published on the topic of BPE, and innovation. The reason for the lack of research on BPE is because BPE is a newly used term that has only been in use since June 2010, and the innovation has not been the core focus of many organisations in the last 20 years. Once the innovative environment had been established within companies, we investigate how the innovative ideas and processes can be used to implement new products and services to customers, and create shareholder wealth.

If you wish to receive feedback regarding the results of this survey, please supply your e-mail address below:

E-mail: _____@_____

If you have any queries please contact:

Researcher: Rayno J. Hattingh – raynohattingh@gmail.com

Please provide the following information regarding yourself:

1. Age:

1	
---	--

 3. Occupation: _____

2. Gender:

1	Male
2	Female

Please answer the following questions by simply making an **X** over your choice.

Example:

1	Yes	~~X~~	No	3	Not sure
---	-----	--------------	----	---	----------

3. Do you agree that an innovative product creates an opportunity for a company to offer its customers something *unique*?

1	Not at all	2	Somewhat	3	Agree	4	Completely Agree
---	------------	---	----------	---	-------	---	------------------

4. Do you think that enhancing innovation turns knowledge into money?

1	No	2	Maybe	3	Yes
---	----	---	-------	---	-----

5. Do you think that the terms **innovation** and **invention** can be used interchangeably?

1	No	2	Not sure	3	Yes
---	----	---	----------	---	-----

6. To what extent do you think creativity generates innovation?

1	Not at all	2	Somewhat	3	More than average	4	Completely
---	------------	---	----------	---	-------------------	---	------------

7. Which one of the following factors do you think influences the success of innovation the most?

1	Innovative capability	
2	Network sufficiency	
3	Market orientation	
4	Don't know	

PLEASE READ THE FOLLOWING!:

Definition: *Business Process Excellence*

Optimising a business process alone, does not mean that new and innovative products will be created. Business Process Excellence is the name for a new discipline that makes organisations fit for global competition. Businesses of the future will rely more heavily on innovative solutions and process management to improve existing processes. Business Process Excellence can be used to quickly recognise deviations and correct them with appropriate measures, or even predict potential errors. Excellent processes connect management, employees, external partners and customers at different locations.

8. Have you ever heard of the concept "Business Process Excellence"?

1	Yes	2	No
---	-----	---	----

9. Do you think that businesses will rely more on innovative solutions to improve existing processes?

1	Yes	2	No	3	Not sure
---	-----	---	----	---	----------

10. Does the attitude of Business Process Excellence sound positive or negative to you..?
(Meaning: *Does the approach appeal to you as a person*)

1	Positive	2	Negative	3	Not sure
---	----------	---	----------	---	----------

11. Do you think it important to include a step in the software development process to explore and share innovative ideas?

1	Yes	2	No	3	Not sure
---	-----	---	----	---	----------

12. Which one of the following describe the term innovation the best:

- ☐ 1 - Innovation is an idea, practise or object that is perceived as new by an individual or other unit of adoption
- ☐ 2 - A new idea has been 'invented' when it is proven to work in the laboratory
- ☐ 3 - Continuous innovation occurs largely because a few key executives have a broad vision of what their organizations can accomplish for the world and lead their enterprises toward it.
- ☐ 4 - It has long been assumed that product innovations are typically developed by product manufacturers...innovators (with)...major influence on innovation research, on management of research and development and government innovation policy...

13. Do you think it is important to **explore** possibilities to improve existing business processes?

1	Never	2	Sometimes	3	Often	4	Always
---	-------	---	-----------	---	-------	---	--------

14. Are you as an employee given the right to fail when trying new things?

1	Never	2	Sometimes	3	Often	4	Always
---	-------	---	-----------	---	-------	---	--------

15. Do you as an employee want to accept responsibility for innovative products or services?

1	Never	2	Sometimes	3	Often	4	Always
---	-------	---	-----------	---	-------	---	--------

16. How many times do you feel that your new ideas for products/services are considered to be good by your boss, or fellow employees?

1	Never	2	Sometimes	3	Often	4	Always
---	-------	---	-----------	---	-------	---	--------

17. Does your company follow a certain process with regard to thinking of new products or services?

1	Yes	2	No	3	Not sure
---	-----	---	----	---	----------

18. Does your company have a centralised repository to collect ideas, or a special room where new products (or services) can be tested?

1	Yes	2	No	3	Not sure
---	-----	---	----	---	----------

19. Do you agree that all innovations (whether products or services) should ultimately contribute to the company's bottom-line, or profits?

1	Yes	2	No
---	-----	---	----

20. Do you think that the implementation of innovations is a critical factor that can increase a company's competitive advantage?

1	Yes	2	No
---	-----	---	----

21. Does your company reward employees that contribute to new products or services?

1	Yes	2	No	3	Not sure
---	-----	---	----	---	----------

22. Does your company encourage an innovative environment?

1	Yes	2	No
---	-----	---	----

23. Does management communicate the company strategy in order to allow employees to actively be involved in the reaching their goals?

1	Yes	2	No
---	-----	---	----

24. At what level of competence do you rate yourself with regard to technology and computer literacy?

1	No knowledge	2	Beginner	3	Intermediate	4	Advanced
---	--------------	---	----------	---	--------------	---	----------

25. Do you think that the implementation of innovations increases a company's competitive advantage?

1	Not at all	2	Somewhat	3	Average growth	4	Absolutely
---	------------	---	----------	---	----------------	---	------------

26. Companies can achieve improved performance through continuous (1) BIG or (2) SMALL innovations?

1	BIG	2	SMALL
---	-----	---	-------

27. Indicate by % which of the following types of project failures occur the most in your company:

1	Never completed	___%
2	Operational / Over budget	___%

3	Over the time estimate	___%
4	Completed with fewer specifications	___%
	TOTAL:	100%

28. How do you think the hours of development will increase when developers pair instead of individual programming to complete a project?

1	Not at all	2	Moderately	3	Strong increase
---	------------	---	------------	---	-----------------

29. Order the following as follows:

- 1 – The biggest reason why software development remains a complex task;
- 2 – 2nd biggest reason why software development remains a complex task;
- 3 – Least influential factor

1	System failures	
2	Project overrun	
3	Unfinished projects	



Insert 1, 2 or 3 in the last box according to your choice of order.

30. To what extent does your company promote organisational learning to enhance knowledge that can be utilised in the future?

1	Not at all	2	Moderately	3	Strongly
---	------------	---	------------	---	----------

31. Do you agree that even the most innovative product needs to be reliable, and of high quality?

1	No	2	Yes	3	Not sure
---	----	---	-----	---	----------

32. To what extent do you agree that as the complexity of the software grows, end users demand enhanced service and zero downtime?

1	Not at all	2	Moderately	3	Strongly
---	------------	---	------------	---	----------

33. Do your current software development processes include the measurement of reliability or productivity?

1	Not at all	2	Yes	3	Not sure
---	------------	---	-----	---	----------

34. Do you think that a small improvement in your software development process can result in an significant improvement in the quality of the software developed?

1	Not at all	2	Yes	3	Not sure
---	------------	---	-----	---	----------

35. Does your software development process enable you to detect defects in the software in the early stages of development, even before testing?

1	Not at all	2	Yes	3	Not sure
---	------------	---	-----	---	----------

36. Do you agree that a step-by-steps process is needed to measure the product quality?

1	Not at all	2	Yes	3	Not sure
---	------------	---	-----	---	----------

37. Would a proactive rather than a reactive approach to software development decrease the defect found in software development?

1	Not at all	2	Yes	3	Not sure
---	------------	---	-----	---	----------

38. Which of the following methods does your company use to add value to your customers?
Mark then with an X, you can choose more than 1

1	Enhancing processes	
2	Enhancing products	
3	Using innovation	

39. Do you think that a reduction in input can produce more output?

1	Not at all	2	Yes	3	Not sure
---	------------	---	-----	---	----------

40. Can the importance of measuring productivity be denied in an organisation?

1	Not at all	2	Yes	3	Not sure
---	------------	---	-----	---	----------

41. Does each process manager in your organisation accept responsibility for the steps involved in software development? *Do they take ownership for their actions?*

1	Not at all	2	Yes	3	Not sure
---	------------	---	-----	---	----------

42. Does your company use the **Deming Circle** model to increase the quality of your processes?

1	Not at all	2	Yes	3	Not sure
---	------------	---	-----	---	----------

Thank you for completing the questionnaire!

ANNEXURE C

Crosstabs

Case Processing Summary

	Cases					
	Valid			Missing		Total
	N	Percent		N	Percent	
Q4 * Q7	32	100.0%		0	.0%	

Q4 * Q7 Crosstabulation

			Q7				Total
			Innovative Capability	Network Sufficiency	Market Orientation	Dont know	
Q4	Maybe	Count	3	2	4	2	11
		% within Q4	27.3%	18.2%	36.4%	18.2%	100.0%
		% of Total	9.4%	6.3%	12.5%	6.3%	34.4%
	Yes	Count	7	9	3	2	21
		% within Q4	33.3%	42.9%	14.3%	9.5%	100.0%
		% of Total	21.9%	28.1%	9.4%	6.3%	65.6%
Total	Count	10	11	7	4	32	
	% within Q4	31.3%	34.4%	21.9%	12.5%	100.0%	
	% of Total	31.3%	34.4%	21.9%	12.5%	100.0%	

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.405 ^a	3	.333
Likelihood Ratio	3.429	3	.330
Linear-by-Linear Association	1.435	1	.231
N of Valid Cases	32		

a. 6 cells (75.0%) have expected count less than 5. The minimum expected count is 1.38.

Symmetric Measures

	Value	Asymp. Std. Error ^a	Approx. T ^b	Approx. Sig.
Nominal by Nominal	Phi	.326		.333
	Cramer's V	.326		.333
	Contingency Coefficient	.310		.333
Interval by Interval	Pearson's R	-.215	.180	-.1.207
Ordinal by Ordinal	Spearman Correlation	-.208	.182	-.1.167
N of Valid Cases	32			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

Crosstabs

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent

Q38_1 * Q9	32	100.0%	0	.0%	32	100.0%
------------	----	--------	---	-----	----	--------

Q38_1 * Q9 Crosstabulation

			Q9			Total
			Yes	No	Not Sure	
Q38_1	No	Count	5	2	4	11
		% within Q38_1	45.5%	18.2%	36.4%	100.0%
		% of Total	15.6%	6.3%	12.5%	34.4%
	Yes	Count	12	3	6	21
		% within Q38_1	57.1%	14.3%	28.6%	100.0%
		% of Total	37.5%	9.4%	18.8%	65.6%
Total	Count	17	5	10	32	
	% within Q38_1	53.1%	15.6%	31.3%	100.0%	
	% of Total	53.1%	15.6%	31.3%	100.0%	

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.396 ^a	2	.820
Likelihood Ratio	.396	2	.820
Linear-by-Linear Association	.333	1	.564
N of Valid Cases	32		

a. 3 cells (50.0%) have expected count less than 5. The minimum expected count is 1.72.

Symmetric Measures

		Value	Asymp. Std. Error ^a	Approx. T ^b	Approx. Sig.
Nominal by Nominal	Phi	.111			.820
	Cramer's V	.111			.820
	Contingency Coefficient	.111			.820
Interval by Interval	Pearson's R	-.104	.177	-.571	.572 ^c
Ordinal by Ordinal	Spearman Correlation	-.106	.177	-.586	.562 ^c
N of Valid Cases		32			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

Crosstabs

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Q38_2 * Q14	32	100.0%	0	.0%	32	100.0%
Q38_2 * Q16	32	100.0%	0	.0%	32	100.0%

Q38_2 * Q14

Crosstab

	Q14			Total
	1	2	3	

Q38_2	No	Count	0	12	3	15
		% within Q38_2	.0%	80.0%	20.0%	100.0%
		% of Total	.0%	37.5%	9.4%	46.9%
	Yes	Count	3	6	8	17
		% within Q38_2	17.6%	35.3%	47.1%	100.0%
		% of Total	9.4%	18.8%	25.0%	53.1%
	Total	Count	3	18	11	32
		% within Q38_2	9.4%	56.3%	34.4%	100.0%
		% of Total	9.4%	56.3%	34.4%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.176 ^a	2	.028
Likelihood Ratio	8.431	2	.015
Linear-by-Linear Association	.182	1	.669
N of Valid Cases	32		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 1.41.

Symmetric Measures

		Value	Asymp. Std. Error ^a	Approx. T ^b	Approx. Sig.
Nominal by Nominal	Phi	.474			.028
	Cramer's V	.474			.028
	Contingency Coefficient	.428			.028
Interval by Interval	Pearson's R	.077	.174	.421	.677 ^c

Ordinal by Ordinal	Spearman Correlation	.127	.185	.699	.490 ^c
N of Valid Cases		32			

- a. Not assuming the null hypothesis.
b. Using the asymptotic standard error assuming the null hypothesis.
c. Based on normal approximation.

Q38_2 * Q16

Crosstab

			Q16				Total
			1	2	3	4	
Q38_2	No	Count	0	4	11	0	15
		% within Q38_2	.0%	26.7%	73.3%	.0%	100.0%
		% of Total	.0%	12.5%	34.4%	.0%	46.9%
	Yes	Count	1	3	11	2	17
		% within Q38_2	5.9%	17.6%	64.7%	11.8%	100.0%
		% of Total	3.1%	9.4%	34.4%	6.3%	53.1%
Total	Count	1	7	22	2	32	
	% within Q38_2	3.1%	21.9%	68.8%	6.3%	100.0%	
	% of Total	3.1%	21.9%	68.8%	6.3%	100.0%	

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.030 ^a	3	.387
Likelihood Ratio	4.177	3	.243

Linear-by-Linear Association	.175	1	.676
N of Valid Cases	32		

a. 6 cells (75.0%) have expected count less than 5. The minimum expected count is .47.

Symmetric Measures

		Value	Asymp. Std. Error ^a	Approx. T ^b	Approx. Sig.
Nominal by Nominal	Phi	.308			.387
	Cramer's V	.308			.387
	Contingency Coefficient	.294			.387
Interval by Interval	Pearson's R	.075	.174	.413	.683 ^c
Ordinal by Ordinal	Spearman Correlation	.108	.173	.596	.556 ^c
N of Valid Cases		32			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

Crosstabs

Notes

Output Created	25-Oct-2011 09:30:34
Comments	
Input	Data
	F:\SKD\Hatingh Rayno\Software Development data.sav
	Active Dataset
	DataSet1
	Filter
	<none>

Missing Value Handling	Weight	<none>	
	Split File	<none>	
	N of Rows in Working Data File		32
	Definition of Missing	User-defined missing values are treated as missing.	
Syntax	Cases Used	Statistics for each table are based on all the cases with valid data in the specified range(s) for all variables in each table.	
		CROSSTABS	
		/TABLES=Q38_3 BY Q22	
		/FORMAT=AVALUE TABLES	
Resources		/STATISTICS=CHISQ CC PHI	
		CORR	
		/CELLS=COUNT ROW TOTAL	
		/COUNT ROUND CELL.	
Resources	Processor Time		00:00:00.000
	Elapsed Time		00:00:00.016
	Dimensions Requested		2
	Cells Available		174762

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Q38_3 * Q22	32	100.0%	0	.0%	32	100.0%

Q38_3 * Q22 Crosstabulation

	Q22	Total
--	-----	-------

			Yes	No	
Q38_3	No	Count	14	7	21
		% within Q38_3	66.7%	33.3%	100.0%
		% of Total	43.8%	21.9%	65.6%
	Yes	Count	7	4	11
		% within Q38_3	63.6%	36.4%	100.0%
		% of Total	21.9%	12.5%	34.4%
Total	Count	21	11	32	
	% within Q38_3	65.6%	34.4%	100.0%	
	% of Total	65.6%	34.4%	100.0%	

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.029 ^a	1	.864	1.000	.582
Continuity Correction ^b	.000	1	1.000		
Likelihood Ratio	.029	1	.864		
Fisher's Exact Test					
Linear-by-Linear Association	.028	1	.866		
N of Valid Cases	32				

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 3.78.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Asymp. Std. Error ^a	Approx. T ^b	Approx. Sig.
Nominal by Nominal	Phi	.030			.864

	Cramer's V	.030			.864
	Contingency Coefficient	.030			.864
Interval by Interval	Pearson's R	.030	.178	.166	.869 ^c
Ordinal by Ordinal	Spearman Correlation	.030	.178	.166	.869 ^c
N of Valid Cases		32			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

Descriptives

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Q1	31	21	43	28.23	7.093
Q3	32	2	4	3.28	.683
Q6	32	2	4	3.25	.718
Q13	32	2	4	3.41	.665
Q14	32	1	3	2.25	.622
Q15	32	2	4	3.31	.644
Q16	32	1	4	2.78	.608
Q24	32	2	4	3.50	.568
Q25	32	2	4	3.44	.716
Q27_1%	32	0	60	14.16	11.745
Q27_2%	32	0	60	22.03	15.126
Q27_3%	32	10	80	34.84	18.556

Q27_4%	32	0	80	29.28	21.169
Q28	32	1	3	2.28	.683
Q29_1	32	1	3	2.06	.564
Q29_2	32	1	3	1.44	.759
Q29_3	32	1	3	2.50	.762
Q30	32	1	3	2.16	.574
Q32	32	2	3	2.53	.507
Valid N (listwise)	31				

Frequency Table

Q2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	26	81.3	81.3	81.3
	Female	6	18.8	18.8	100.0
	Total	32	100.0	100.0	

Q3_Occupation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Candidate Technician	1	3.1	3.2	3.2
	Developer	4	12.5	12.9	16.1
	Engineer	3	9.4	9.7	25.8
	IM Officer	1	3.1	3.2	29.0
	IT Administrator	1	3.1	3.2	32.3

	IT Manager	1	3.1	3.2	35.5
	IT Specialist	1	3.1	3.2	38.7
	IT Technician	2	6.3	6.5	45.2
	IT Support Service	1	3.1	3.2	48.4
	Lecturer	2	6.3	6.5	54.8
	Programmer	1	3.1	3.2	58.1
	Project Manager	1	3.1	3.2	61.3
	Senior Analyst	1	3.1	3.2	64.5
	Social Worker	1	3.1	3.2	67.7
	Software Developer	5	15.6	16.1	83.9
	Student	5	15.6	16.1	100.0
	Total	31	96.9	100.0	
Missing	System	1	3.1		
Total		32	100.0		

Q4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	11	34.4	34.4	34.4
	3	21	65.6	65.6	100.0
	Total	32	100.0	100.0	

Q5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	13	40.6	40.6	40.6
	2	6	18.8	18.8	59.4
	3	13	40.6	40.6	100.0

Total	32	100.0	100.0	
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Q7

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	10	31.3	31.3	31.3
	2	11	34.4	34.4	65.6
	3	7	21.9	21.9	87.5
	4	4	12.5	12.5	100.0
	Total	32	100.0	100.0	

Q8

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	7	21.9	21.9	21.9
	2	25	78.1	78.1	100.0
	Total	32	100.0	100.0	

Q9

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	17	53.1	53.1	53.1
	2	5	15.6	15.6	68.8
	3	10	31.3	31.3	100.0
	Total	32	100.0	100.0	

Q10

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	27	84.4	84.4	84.4
	2	3	9.4	9.4	93.8
	3	2	6.3	6.3	100.0
	Total	32	100.0	100.0	

Q11

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	29	90.6	90.6	90.6
	3	3	9.4	9.4	100.0
	Total	32	100.0	100.0	

Q12

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	23	71.9	71.9	71.9
	2	1	3.1	3.1	75.0
	3	5	15.6	15.6	90.6
	4	3	9.4	9.4	100.0
	Total	32	100.0	100.0	

Q17

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	11	34.4	34.4	34.4
	2	10	31.3	31.3	65.6

3	11	34.4	34.4	100.0
Total	32	100.0	100.0	

Q18

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 1	8	25.0	25.0	25.0
2	20	62.5	62.5	87.5
3	4	12.5	12.5	100.0
Total	32	100.0	100.0	

Q19

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 1	23	71.9	71.9	71.9
2	9	28.1	28.1	100.0
Total	32	100.0	100.0	

Q20

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 1	30	93.8	93.8	93.8
2	2	6.3	6.3	100.0
Total	32	100.0	100.0	

Q21

	Frequency	Percent	Valid Percent	Cumulative Percent
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Valid	1	10	31.3	31.3	31.3
	2	9	28.1	28.1	59.4
	3	13	40.6	40.6	100.0
	Total	32	100.0	100.0	

Q22

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	21	65.6	65.6	65.6
	2	11	34.4	34.4	100.0
	Total	32	100.0	100.0	

Q23

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	21	65.6	65.6	65.6
	2	11	34.4	34.4	100.0
	Total	32	100.0	100.0	

Q26

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	9	28.1	28.1	28.1
	2	23	71.9	71.9	100.0
	Total	32	100.0	100.0	

Q33

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	3	9.4	9.4	9.4
	2	17	53.1	53.1	62.5
	3	12	37.5	37.5	100.0
	Total	32	100.0	100.0	

Q34

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	26	81.3	81.3	81.3
	3	6	18.8	18.8	100.0
	Total	32	100.0	100.0	

Q35

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	4	12.5	12.5	12.5
	2	17	53.1	53.1	65.6
	3	11	34.4	34.4	100.0
	Total	32	100.0	100.0	

Q36

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	2	6.3	6.3	6.3
	2	26	81.3	81.3	87.5
	3	4	12.5	12.5	100.0

Total	32	100.0	100.0	
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Q37

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	23	71.9	71.9	71.9
	3	9	28.1	28.1	100.0
	Total	32	100.0	100.0	

Q38_1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	11	34.4	34.4	34.4
	1	21	65.6	65.6	100.0
	Total	32	100.0	100.0	

Q38_2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	15	46.9	46.9	46.9
	1	17	53.1	53.1	100.0
	Total	32	100.0	100.0	

Q38_3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	21	65.6	65.6	65.6
	1	11	34.4	34.4	100.0

Total	32	100.0	100.0	
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Q39

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 1	9	28.1	28.1	28.1
2	10	31.3	31.3	59.4
3	13	40.6	40.6	100.0
Total	32	100.0	100.0	

Q40

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 1	15	46.9	46.9	46.9
2	5	15.6	15.6	62.5
3	12	37.5	37.5	100.0
Total	32	100.0	100.0	

Q41

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 1	4	12.5	12.5	12.5
2	18	56.3	56.3	68.8
3	10	31.3	31.3	100.0
Total	32	100.0	100.0	

Q42

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	6	18.8	18.8	18.8
	2	4	12.5	12.5	31.3
	3	22	68.8	68.8	100.0
	Total	32	100.0	100.0	

Company

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Compusoft France	1	3.1	3.1	3.1
	Compusoft Norway	6	18.8	18.8	21.9
	Mineware	1	3.1	3.1	25.0
	NWU	22	68.8	68.8	93.8
	Signify	2	6.3	6.3	100.0
	Total	32	100.0	100.0	