INTRODUCTION

1 Introduction

Innovation has been, currently is and will also be one of the most crucial business practises of all time. Unlike the many remarkable new business concepts that are often only 'flavour of the month' insights, innovation is a constant reminder to business, to improve, renew and change. Recent advances in technology, and a resurgence in business thinking, are raising the development of improvement techniques in areas such as technology management, core competence analysis, customer relations and many others. Innovation, although not exactly a new concept, has often been neglected and left 'to happen on its own'. Managers were heard to say it is too haphazard to manage innovation, and one should be happy when the results are positive. This thinking may be slowly changing as academics and innovative organisations better understand the process of innovation. Coupled to this change in mindset, the discipline of auditing the innovation process, may also become a crucial part in improving innovation.

This thesis focuses on improving an organisation's capabilities to implement technology through the process of innovation auditing. The audit will focus on maximising the organisation's success at innovation and specifically technological innovation by identifying key competencies in innovation. It aims to develop a methodology for the auditing of these key competencies by comparing the best innovation practises, as identified within the innovation discipline, with them.

The proposal to do an innovation audit at any organisation often creates the misconception that a measurement of the outputs of its innovation process will be made. Often auditors are inundated with explanations on the amount, type or successes of the innovations of the organisation over the past year. However, innovation auditing goes deeper than simply looking at the outputs from the innovation process. Rather, it focuses on the steps followed during the innovation process, to better understand and improve the actual process. By focussing on the steps, as well as the competencies associated with them, the innovation audit is able to improve the innovation process, by pointing out strengths and weaknesses in the organisation's innovation process.

Developing a technological innovation audit is not a trivial task. The field of innovation is incredibly wide, and exacerbating this are the many different methods for classifying the field. This may be seen in the many different innovation models and proposals for improving the process, as well as in the volumes of literature and research available on defining different aspects of the process. In the process of developing an innovation audit, this thesis found it necessary to define the technological innovation process, and set a foundation upon which a questionnaire may be built. However in defining technological innovation, reaction is immediately

elicited, thus care was taken to outline the reasons for defining innovation the way it was done.

With a working definition of technological innovation in hand, the thesis could proceed towards the development of a methodology for auditing technological innovation. This included finding and categorising best practises in innovation, constructing an audit questionnaire and finding a suitable methodology for implementing an innovation audit in an organisation. However, while researching the best practises of innovation, one came to the realisation of the poor holistic structure in the innovation discipline. Often applicable models or formats in which the best practises of innovation could be structured for conducting an innovation audit do not seem to exist. The conclusion that such a model had to be developed, before an innovation audit was possible, was made. This led to the research and development of an innovation model suitable to form the foundation for a technological innovation audit.

While developing the model for innovation, the author came to the realisation of the duality of the innovation process. Traditionally innovation is portrayed as mechanistic processes and procedures inside an organisation, or conversely as a random conglomeration of processes, to develop a new product. However, all these portrayals clearly disregard the human involvement in the process of innovation, and here is where the possible duality was first discovered. Innovation consists of a *mechanistic causal process* as well as a *human almost random inv*olvement. By integrating the two, many difficulties are experienced in defining the innovation process. However if these two sides of the same coin are split, innovation becomes much easier to understand and classify.

The realisation of the *duality of innovation* was seen as a breakthrough in the development of an innovation audit. The possibility therefore exists to construct two different methods, one qualitative, the other quantitative for measuring the innovation process. This clearly illustrated the reason why literature on innovation seems to integrate 'soft' human issues with 'hard' procedures. Therefore by measuring the mechanistic process side of innovation in a quantitative way, and measuring the human random side of innovation in a qualitative way, each area could be measured with the best possible method.

A decision was made to concentrate on qualitative measurement of the innovation process, since much research and development has already been done in the mechanistic process side of innovation. Systems engineering and new product development are the forerunners in this development and it was felt that the biggest contribution to innovation might be made in the field of human capabilities, and how to improve them to the advantage of the innovation process.

The focus of the innovation audit in this thesis therefore, lies in the identification and measurement of best competencies for technological innovation, in medium to large organisations.

The proposed model for innovation illustrates the duality of the innovation process clearly. It aims to provide a holistic representation of an observed and temporary reality for the innovation process. Because innovation has no absolute methods that will guarantee success, the model may only portray the observed reality as proposed and practised in innovative organisations. The model serves as foundation for the many different best competencies that may be identified in the innovation process. By creating an anchor point, the model enables the researcher to sort these best competencies and find where, when, and how they should integrate with the

innovation process. Therefore by building an innovation model and a best competence field around it, the researcher may be able to construct a temporary best innovation method, which may serve as the standard for the innovation audit.

It is from this standard which incorporates the proposed model and best competencies, that the innovation audit may be constructed. By asking questions on the various aspects of the standard, the auditor may extract the current state of the innovation process at an organisation. Such a process may be formalised in the form of an audit questionnaire, and that is why a questionnaire was developed in this thesis. Although a questionnaire may extract information, a methodology for implementing the parts of the innovation process still had to be developed.

The methodology initially took the form of a financial audit, but soon changed. Due to the quantitative nature of financial auditing methodologies, it was found to be of little practical use. Only some of the causal methods, for finding and analysing the audit data, were used. A much better methodology was found in the form of an innovation audit by Chiesa *et al.*[10] The methodology in this audit focuses on implementing a questionnaire, as well as supplying the answers. By means of a rubric from one to four, these could then be picked by the auditee, and subsequently improve the results from the audit.

With an adequate methodology and an audit questionnaire, the verification of all the proposals made in this thesis, were tested at five South African organisations. Agreement on the innovation model was quite apparent, although some negativity was experienced with the questionnaires. This was attributed to the disinterest shown with innovation, and the amount of time it took to complete the questionnaire. The results indicate that certain industries may exhibit certain strengths and weaknesses. The results also indicated that the innovation audit is relative, and should not be used for calibration, but rather for identifying the strengths and weaknesses of the organisation's innovation competencies.

1.1 Overview

The thesis consists of seven chapters and an addendum.

Chapter two presents the conundrum of defining innovation, technology as well as technological innovation. Based on the work by Utterback and Abernathy,[1] Freedman,[2] Edosomwan,[3] Drucker,[4] Marquis,[5] Henderson and Clark[6] and others, chapter two focuses on the development of definitions in the fields of technology, innovation, and technological innovation. These definitions serve to qualify the assumptions made later in the thesis, as well as setting some boundaries to the innovation audit. Management practises for innovation and technology are covered as well, since they influence the innovation audit procedures.

A sound understanding of the dynamics of technology and innovation is necessary, to be able to develop an audit for technological innovation. Since different types of innovations are possible, the boundaries to technology and innovation become important. Deciding between radical and incremental innovation can radically alter the questions asked in an innovation audit. Making an informed decision on the type of innovation, as well as the scope of the audit is only possible through knowledge of innovation, technology and the management of both these disciplines.

Chapter three discusses the development of different models, to portray complex processes such as innovation, product development or technology management. It

dwells on the basic discipline of modelling, and then progresses towards developing a model for the technological innovation process. Legendary models from Utterback[1] and Twiss[7] are displayed, as well as referrals to other more recent ones from gurus such as Tidd *et al*,[8] Edosomwan,[3] Roberts[9], Marquis[5] and others.

Modelling serves the purpose of creating a visible representation of a process, and in so doing sets a standard for future development in the discipline. By modelling the innovation process, one might also identify the relationships between different disciplines within the innovation process. This may lead towards understanding the inner workings of innovation better, as well as integrating these disciplines into a sensible and holistic entity that represents the total innovation process.

A model may serve as structure for the innovation audit. By identifying the key areas of focus in the innovation process, the model enables the audit to target the high impact areas.

The chapter is concluded with an example of adapting the proposed innovation model, to the needs and processes of the organisation. Such an 'organisation specific innovation model', is powerful in its representation of the interaction between elements of the innovation processes in the organisation. It may often be used as a benchmark or an action plan, for improving the organisation's innovation methodology.

Chapter four focuses on methodologies for auditing in general, as well as developing a proposed methodology for auditing competencies for technological innovation. Auditing is a method for measuring and validating data from various business processes.[10] Most business processes may be audited, if data is available for comparison, with a certified or known standard. One of the best-established audit disciplines is financial auditing, while others include technology audits, core competence audits, business process audits and many others.

Methodologies for financial auditing have been perfected through trial and error. Over many years the discipline of financial auditing has grown to be a key ingredient in generally accepted management practises. Fortunately these well-tested methodologies may be employed in the innovation audit as well. By actively incorporating financial audit methodologies in the innovation audit, a strong base is formed from where future developments may be done. The thoroughly developed methodologies of financial auditing may also enhance the structure and understandability of the innovation audit.

The possible application of these methodologies in the discipline of innovation auditing is researched in the latter parts of the chapter. Some other examples focussing on innovation audits will also be discussed. Finally the methodology for the proposed technological innovation audit is discussed.

Chapter five defines 'best practices' in innovation and aims to set a standard whereby organisations may measure their innovation practises. Defining 'best practise standards' for successful innovation is not a trivial task. This chapter aims to present a non-exhaustive, but high-impact proposal to the best practises in innovation. The secondary aim is to provide a backdrop for the innovation audit questionnaire, developed for use in a competence audit for technological innovation. The beta test version of the questionnaire is included in the addendum. [Appendix B]

The chapter takes its structure from the innovation model developed in a previous chapter, as well as various sources in literature including Thwaites,[11] Student,[12] Tidd *et al,*[8] Chiesa *et al,*[10] and many others. By keeping the model close at hand for easy referral, aspects of the model may also become clearer.

The external environment to the organisation is discussed first, since it is often one of the more generic areas of innovation. The four areas, which form a part of the external environment, may be identified as Technology, Market and Customer, Industry and Political, Economical and Social.

The second part of the 'best practises' in innovation, focuses on business structures and resources of the organisation. By examining the heart of the organisation, including its structures, resources and leadership, one might form an opinion on the organisation's innovation fostering nature. The 'best practise' section on the organisation may be divided into Strategic, Implementation and Fostering Environment.

Thirdly, the individual, an often-unmentioned part of the innovation process is examined and highlighted for best innovation practises or competencies. Innovation will not happen without human involvement and their knowledge, competencies, influences and needs should be taken into account when proposing a 'best practise standard' for innovation. The section on individuals may be divided into *personality and emotions, knowledge, experience and background*, and *interactions*.

Chapter six reaches the conclusion of this thesis in the form of an innovation audit. It contains reasons for selecting various questions as well as the questions themselves. Since the questions are based on the best practises in chapter five the chapter only provides the final questions which were used in the innovation audit questionnaire. It would have been impractical to include all the questions which were considered or thought of.

Further more the chapter includes the implementation of the proposed innovation audit questions. A beta test audit process was completed at five South African organisations. During this test period it was possible to test the proposed innovation model, the proposed audit methodology and the audit questionnaire. The audits proved to be successful and enabled the auditor to update and improve the implementation methodology as well as the questions in the audit questionnaire.

The chapter will illustrate the procedures followed to beta test the audit questionnaire. Some of the results from the beta test process will be discussed, as well as their significance for the innovation audit methodology. The chapter will conclude with remarks on the implementability of the questionnaire, and proposed audit methodology as discussed in chapter five. The innovation model and the best practise standards discussed in chapters three and five respectively, will be reviewed on the basis of the beta test as well.

Chapter Seven discusses the validity of the proposed innovation audit, model and methodology. It highlights some of the limitations and advantages of the proposed innovation audit. The final section contains a personal opinion relating some of the perceptions and findings of the author.

The addendum contains some research on the importance of innovation [See appendix A], as well as the audit questionnaire, which was tested in chapter six [See

appendix B]. Innovation models are provided in appendix-D while appendix-E contains the results from the beta innovation audit tests.

1.2 References

[1] Utterback J. M., Abernathy W. J. [1975] "A Dynamic Model of Process and Product Innovation". *Omega* no. 6, pp. 639-656.

[2] Freeman C., [1982] *The Economics of Industrial Innovation*, (2nd edn). Frances Printer, London.

[3] Edosomwan J.A., [1989] *Integrating Innovation and Technology Management*, John Whiley & Sons, Canada.

[4] Drucker P., [1985] *Innovation and Entrepreneurship*, Butterworth-Heinemann, Oxford.

[5] Marquis D.G., [1969] "The Anatomy of Successful Innovations", *Innovation*, November. Reprinted in M.L. Tushman and W.L. Moore, Eds. *Readings in the Management of innovation*, Marshfield, MA, 1982.

[6] Henderson R.M. and Clark K.B., [1990] "Architectural innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms", *Administrative Science Quarterly*, Vol. 35 pp. 9-30.

[7] Twiss B., [1974] *Managing Technological Innovation*, Longman Group Limited, London.

[8] Tidd J., Besant, J., Pavit, K. [1997] *Managing Innovation, Integrating Technological, Market and Organisational Change*, Wiley, UK.

[9] Roberts B., [1987] *Generating Technological Innovation*, Oxford University Press, Oxford.

[10] Chiesa V., Couglan P., Voss C.A., [1996] "Development of a Technical Innovation Audit", *Journal of Product Innovation Management*, vol. 13, pp. 105-136.

[11] Thwaites D., [1992] Organisational Influences on the New Product Development Process in Financial Services" *Journal of Product Innovation Management*, vol. 9, pp. 303-313.

[12] Student K. R., [1978] Managing change: A Psychologists Perspective", *Business Horizons*, pp.28-33.