

## Chapter1-Background and the research problem

*“Measurement is one of our most ordinary actions. We speak its language whenever we exchange precise information (Alder, 2004:2)”*

### 1.1 Introduction

The concept of measurement is pervasive to everyday life. The history of measurement and mathematics shows that man has practiced measurement for thousands of years but only in recent ages has anyone analyzed the meaning of what he did (Abdel-Magid, 1979:346). It was the need for reliable information about man’s environment that gave rise to the concept of measurement. Information that is reliable reduces the uncertainty about the physical world in everyday decision making.

In this study, it is important to note that some of the references used are over seven decades old. This is because research in accounting measurement has been very limited. During the literature analysis carried out in this study, it was established that research on accounting measurement conducted over sixty years ago (e.g., see, Gillman, 1939; Paton and Littleton, 1940) is still relevant to this day. Furthermore, the last major attempt to create a theory of accounting measurement was made by Ijiri (1975). Since then, there have been no major attempts to formulate a theory. The concept of accounting measurement that was relevant over sixty years ago is still relevant today.

Moreover, the references to theories of measurement used in this study consist mainly of research work that was carried out over eighteen years ago (see, Luce, 1996). Since the creation of the modern measurement theory by Scott and Suppes in 1958, and the establishment of the three volumes of the *The Foundations of Measurement* by Luce, Krantz, Suppes and Tversky (1971, 1989, 1990), there have to date been no new perspectives on the principles of

measurement. For this reason these old reference are considered to be relevant to this study.

Measurement is a mathematical concept. According to Stevens (1951:1), the concept of measurement is useful to the extent that the attributes of the objects being studied can be represented by mathematical principles. This suggests that measurement conveys information about the physical world that would not be available without the use of mathematical principles. It can be inferred that measurement is applicable to phenomena that possess characteristics that can be represented with the principles of mathematics. This requires that the properties of the phenomenon being measured are identical to the mathematical properties used to represent it. For example, the height of a man expressed in centimetres should be equivalent to his non-metrical height.

According to Ackoff (1962:195), there is no general agreement among scientists and philosophers on what measurement is and how it should be performed. This has given rise to different views of measurement in the natural and social sciences. Currently, there are two theories of measurement: classical and modern (Michell, 1995). The classical theory views measurement as the assignment of numerals to represent empirical properties of physical phenomena (Michell, 1995:245). Under this concept, numbers are intrinsic to the situations to which they are applied. The numbers are the empirical properties of the physical phenomena that are being described. The classical theory of measurement is applicable to the natural sciences (Mattessich, 1964). This indicates that in the natural sciences the properties of empirical phenomena are identical to the numbers used to represent them. From this it follows that, in the natural sciences, the properties of empirical phenomena can be inferred from the numbers used to represent them.

The modern measurement theory is also known as the representational theory of measurement (Luce *et al*, 1971, 1989, 1990). Scott and Suppes (1958) developed this theory, as the classical theory of measurement was not applicable to the

social sciences. The classical theory of measurement was not applicable to the social sciences due to the fact that it takes the empirical view of the number. Under this theory a number is supposed to represent the empirical properties of the phenomenon it is representing. However, in social sciences numbers do not always represent the empirical properties of the phenomenon they are representing. Sometimes they are used as a form of physical identification. The representational theory of measurement covers measurements in both the social and the natural sciences. According to Narens (2002) the representational theory comprises many related theories of measurement. He argues that what they have in common is that they require a scale to be a set of structure preserving mappings (e.g., a set of isomorphisms or homomorphisms) from some qualitative or empirically based structure into a structure from pure mathematics. Homomorphic or isomorphic transformations do not always result in the representation of the empirical properties of the algebraic structure being transformed to another algebraic structure. It is therefore evident from this that under the representational theory, numerical assignments that do not result in the representation of the empirical properties of the object that is being measured by the numerals assigned are also considered to be measurements. For this reason, the representational theory of measurement is also applicable to social sciences.

The concept of measurement is currently employed in the accounting discipline (see, IASB, 2006; Wolk, Tearney and Dodd, 2001). It is evident from this that a particular theory of measurement will be used in accounting depending on whether accounting is a physical or a social science. Accounting is classified as a social science (Ryan, Scapens and Theobald, 2002:9). Consequently, the theory that is applicable to this discipline is the representational theory of measurement. An analysis of the accounting literature indicates that the concept of measurement forms an important part of accounting terminology. Definitions and accounting practice also suggest that accounting is a measurement discipline (e.g. AICPA, 1941; Bierman, 1963; IASB, 2006; Wolk *et al*, 2001). For this reason, accounting

practice ought to comply with the principles of the representational theory of measurement.

Representational measurement literature (Luce *et al*, 1990:323) asserts that every process of measurement must have an underlying theory of measurement. Consequently, it would be expected that the accounting discipline would have an underlying theory of measurement. However, attempts to formulate a theory of accounting measurement have failed and there is consensus on this point (e.g. Gilman, 1939; Goldberg, 2001; Ijiri, 1975, 1967; Littleton, 1953; Staubus, 1985). The reasons attempts to formulate a theory of measurement failed in accounting are many. They range from outright misunderstanding of the theory of measurement, to the inability of accountants to distinguish what is measurable from what is not in accounting. Some of these failures are elaborated upon in section 1.2 below. This lack of success suggests that the accounting concept of measurement is not in harmony with the principles of the representational theory of measurement.

Given the contradictory views in the discipline on whether or not accounting is a measurement discipline, it is necessary to investigate whether the accounting concept of measurement reflects the principles of a true measurement discipline. The purpose of this chapter is to outline the background of the research study and the research problem. The chapter also briefly outlines the methodology used in this study.

Following the introduction, a brief literature review is conducted in section 1.2, followed by the statement of the research problem in section 1.3. A motivation for researching the problem is presented in section 1.4. The importance of the proposed work and the possible beneficiaries of the outcome of this research are discussed in section 1.5. The hypothesis is presented in section 1.6, while the research aims and objectives are outlined in section 1.7. In section 1.8, a brief outline of the research methodology followed in this work is presented. The chapter layout of this study is presented in section 1.9.

## 1.2 Literature review

The application of measurement theory to accounting is not a new idea. Vickrey (1970), noticing the lack of a measurement theory in accounting, questioned the status of accounting as a measurement discipline. He applied the realist's theory of measurement to evaluate whether accounting was in fact a measurement discipline. The realist's theory of measurement advocates that measurements should reflect the empirical properties of the object they are representing (Michell, 1995). This means that measurements should reflect the intrinsic properties of the object being measured. Vickrey (1970) came to the conclusion that accounting is not a measurement discipline and that there is no property that is currently measured in accounting apart from the numerosity of monetary units. This suggests that there is no theory of measurement in the accounting discipline apart from a theory that describes the measurement of monetary units.

Vickrey (1970) also points out that the nominal scale is not a scale of measurement, and that the existence of an extensive property is necessary in order for accounting to be a measurement discipline. A nominal scale is a scale that reflects only the identity of the object that it is measuring. It does not reflect the empirical properties of this object (see chapter 4). Vickrey's assertion indicates that he used the realist's theory of measurement to evaluate whether accounting was a measurement discipline. The realist's perspective of measurement takes the empirical view of a number (Michell, 1995:245). Numbers are supposed to represent the empirical properties of the phenomena that they represent. But the nominal scale does not have properties that are beyond identity and difference (Stevens, 1951:25). This suggests that the nominal scale does not reflect the intrinsic properties of the phenomenon being measured, and implies further that that a nominal scale cannot be a scale of measurement under the realist's perspective of measurement.

The difficulty with Vickrey's (1970) study is that in his attempt to evaluate whether accounting is a measurement discipline he applied the principles of the realist's

theory of measurement. According to Luce *et al.* (1971), the realist's theory is suitable to the natural sciences. Accounting is a social science (Tinker, 1985) and so a theory of measurement that is appropriate to social sciences should be used. Mattessich (1964) also points out that accounting measurements cannot be inferred through natural laws, but through the intuition of the experimenter. It is evident from this that accounting measurements are dependent on the judgments of the accountant. It follows, then, that accounting measurement should be viewed relative to the environment of the accountant. Furthermore, even though this view is old, it is still applicable today in accounting (see Ryan *et al.*, 2002). Consequently, it can be argued that the theory of measurement that should be used to evaluate whether accounting is a measurement discipline should always involve a conventional component, that is, the agreement to code certain empirical attributes with certain numbers, and certain empirical relations with certain numerical ones. Thus, the principles of the representational theory of measurement (Decoene *et al.*, 1995) that equate measurement to numerical coding should have been used by Vickrey (1970), instead of the realist's theory of measurement, in order to establish whether accounting is a measurement discipline.

Furthermore, Vickrey's (1970:738) belief that an extensive property is necessary for accounting to be a measurement discipline is beset with problems. Accounting is a social science. Luce *et al.* (1971) point out that there are problems in the application of extensive measurement to social sciences. This is because of the inadequate interpretation of the concatenation operation in the measurement of non-physical attributes. However, Luce *et al.* (1971) also indicate that some attributes of the social sciences can be measured extensively; and subjective probability is an outstanding example. But it would be unfair to apply a theory of measurement that only applies to a minority of attributes in a discipline. Such a theory would not make accounting a measurement discipline.

The IASB framework (2006) for financial reporting points out that the attribute of accounting phenomena that is subject to measurement is value. This suggests

that for accounting to be a measurement discipline, there must be a theory of value measurement. Abdel-Magid (1979) asserts that the property subject to measurement in an exchange transaction is exchange value, which is measured by the monetary numerosity at the time of exchange. He also argues that accounting is a social science and, as a result, measurement that is used in social science should be applied in accounting. It can be inferred from this that in the accounting discipline monetary units represent the properties of the values of accounting phenomena. This suggests that the assignments of monetary units to the values of accounting phenomena in exchange transactions are expected to be processes of measurement.

However, Abdel-Magid's (1979) argument does not take into account that, for the measurement of value to occur, a prerequisite (Luce *et al.*, 1971:13) of representational measurement is that a qualitative structure of value should be specified. Currently, the concept of value is considered to be an ambiguous one that is not an intrinsic property of an accounting entity (McLean, 2006). This means that there is no agreement among accountants on the empirical properties of value. It follows that, currently, value cannot be empirically tested in the accounting discipline. According to Decoene *et al.* (1995), magnitudes are historically and theoretically determined reflections of quantitative aspects of objectively existing entities and not merely the outcome of metricization or measuring procedures. This suggests that the phenomenon that is subject to measurement must be empirically testable. It can also be inferred that measurement is applicable only to objective phenomena. Therefore, it can be concluded that value is not currently measurable in accounting.

Other notable attempts to develop a theory of accounting measurement are those by Ijiri (1965, 1975) and Mattessich (1964). None of Ijiri's (1965, 1975) attempts at developing such a theory are in harmony with the principles of the representational theory of measurement. For example, the value allocation rule of measurement (Ijiri, 1965) reveals the author's lack of understanding of the principles of measurement. The value allocation rule suggests that the adding of

values allocated to outgoing resources produces a meaningful value for the decrease in resources resulting from an exchange. Yet, the addition operation in accounting is not given a qualitative interpretation so that the resulting total has an empirical interpretation. According to Luce *et al.* (1971), the application of extensive measurement to non-physical attributes of objects needs an adequate interpretation for the concatenation operation. In the absence of an adequate interpretation of this operation, measurements that are not similar could be added to each other.

Moreover, Ijiri's study (1975) demonstrates a lack of understanding of the principles of representational measurement. According to Ijiri (1975), measurement is not concerned with a single object, but rather with a relation among objects. This viewpoint demonstrates an inadequate understanding of the concept of measurement. Firstly, the concept of measurement assigns numbers to attributes of objects and not the objects themselves. Therefore, it is possible for measurement to be concerned with the attributes of a single object. Secondly, relations can also be found among the attributes of the same object and not only among attributes of different objects. Another crucial point that discredits Ijiri's (1975) attempts to develop a theory of accounting measurement is his inability to distinguish between measure theory and measurement theory. Orbach (1978) points out that part of the reason for Ijiri's (1975) failure to examine the qualitative basis of accounting measurement lies in the fact that he uses measure theoretic concepts instead of measurement theoretic concepts. Measure theory does not require the specification of the attribute to be measured, while measurement theory does. In Ijiri's (1975) study there are no specified attributes that are the subject of measurement. This indicates that Ijiri (1975) used measure theory in his attempt to create a theory of accounting measurement.

### **1.3 Problem statement**

In section 1.1 it was pointed out that accounting is currently believed to be a social scientific measurement discipline. This has led to the premise that accounting practices reflect the properties of a true measurement discipline in the social



science category. Various authors (e.g. Gilman, 1939; Ijiri, 1975, 1967; Littleton, 1953; Staubus, 1985; Vickrey 1970) have over time voiced consensus that the accounting discipline has not succeeded in creating a theory of accounting measurement from the observation of accounting practices of value measurement. According to Ryan *et al.* (2002:118), every process of measurement must have a theory of measurement. Consequently, this suggests that the accounting concept of measurement does not reflect the properties of a true measurement discipline in its category. This leads to confusion as to whether or not accounting is a measurement discipline.

According to the IASB framework (2006, Para 83) for financial reporting, an item that meets the definition of an element of financial statements should be recognized if it has a cost or value that can be measured with reliability. It can be inferred from this viewpoint that the objects of measurement in the preparation of financial statements are cost or value. Consequently, theories of measurement that should exist in the accounting discipline are those of value measurement and cost measurement. Therefore, it can be deduced that theories of measurement that are lacking in the accounting discipline are those of cost measurement and value measurement. It can also be deduced that there are no foundations of value measurement and cost measurement.

Tinker (1985:78) highlights the fact that the theory of value used in accounting does not adequately describe all the value assignments given to the elements of financial statements. He argues that this inadequacy is caused by the fact that the accounting discipline focuses on the marginalism theory of value, neglecting other competing theories. The marginalism theory of value advocates that the value of a commodity is determined by its price (Tinker, 1985). This view indicates that the accounting discipline does not have a comprehensive theory of value. It can thus be inferred that accountants do not have a precise definition of value in accounting. It can be further inferred that the focus of the accounting discipline on the marginalism theory of value indicates that accountants do not have a broad perspective of the drivers of value in accounting. That is to say, accountants are

not aware of the potential contributions that other competing theories of value can bring to accounting. Consequently, the accounting discipline cannot adequately describe perspectives of value that are not covered by the marginalism theory of value.

The marginalist theory of value holds that the price paid to acquire a commodity represents the value of that commodity (Debreu, 1959). In this case, he argues that the value of the commodity is reflected by the utility that the buyer expects to derive from its consumption. Authors such as Dobb (1937) and Tinker (1985), note that utility is both ambiguous and subjective. This suggests that value of utility cannot be empirically verified. It follows that there may be numerous prices that can be used to represent the same amount of utility. Furthermore, there might be more than one theory for measuring the value of a commodity.

Accounting research also indicates that there is confusion in the accounting discipline with regard to the identity of the central ideas of accounting measurement practices. Staubus (2004, 1985), and Chambers (1997) note that there are no standardised accounting measurement practices. They argue that the choice of an accounting practice is dependent on its convenience to the user. This leads to the incompatibility of accounting practices of measurement across different frames of reference. Staubus (1985:53) describes the situation as follows:

If a scientist far removed from accounting asked an accountant to tell him the central ideas of accounting measurement practices, what could the accountant say? Could he say that historical cost is the basis of accounting measurement? Surely he could not feel that he has conveyed the essence of the subject by reference to a principle that applies to a minority of balance sheet items?

This extract indicates that there are numerous practices of accounting measurement that are not coherent. It is also clear that none of the practices of accounting measurement can give rise to a theory that explains in totality the

accounting concept of measurement. Since every process of measurement must have an underlying theory, it is questionable whether these accounting practices are measurement practices after all. Staubus (1985:53) supports this when he states:

To my knowledge, no one has woven accounting measurement practices into a coherent, comprehensive theory.

These words indicate that there is a great deal of literature on accounting measurement, but none of this has managed to provide an appropriate outline of a theory of accounting measurement. The sentence also alludes to the lack of success of the accounting discipline in trying to weave accounting measurement practices into a comprehensive and coherent theory of accounting measurement. It should be noted that every measurement practice must have an underlying theory (Ryan *et al.*, 2002). If different accounting measurement practices cannot be integrated into a comprehensive and coherent theory, it could mean that these practices follow different underlying theories of measurement. It could also mean that different accounting measurement practices are measurement practices for different attributes. It would then follow that such practices are based on different theories of measurement.

Chambers (1997) makes the point that there are no foundations of accounting measurement. In particular, he notes that there are no specified scales of measurement or attributes that are of use and interest to measurement, or specified units in the scales of measurement. Since the IASB (2006, Para 83) identifies cost and value as the objects of measurement in accounting, it could be inferred that the properties of cost and value that are measurable are not specified or identifiable in the accounting literature. But, the principles of representational measurement require the specification of scales of measurement, attributes that are of use and interest to measure and units in the scales of measurement (Luce *et al.*, 1971:12). The question that must be asked, therefore, is how measurement can take place in accounting in the absence of specified foundations of

measurement. In order to answer this question, it is necessary to investigate whether the current concept of measurement in accounting is in harmony with the principles of the representational theory of measurement.

## 1.4 Motivation

The motivation for this study is to add to the body of knowledge on accounting measurement. The problem addressed in this thesis concerns the lack of a theory of accounting measurement. It has been noted in section 1.3 that there is consensus in the accounting discipline that accounting researchers (e.g. Gilman, 1939; Ijiri, 1975, 1967; Littleton, 1953; Staubus, 1985; Vickrey, 1970) have not succeeded in creating a theory of accounting measurement. This lack of success implies that accounting might not be a measurement discipline as previously believed. It is thus essential to find the reason accounting is referred to as a measurement discipline in the absence of a theory of accounting measurement. Furthermore, it would initiate an evolutionary process that would help create foundations of accounting measurement, and thus make accounting a true measurement discipline. If this was achieved, it would make information in financial statements more reliable and objective. This is because all measurement information must be empirically verifiable and must not change its meaning irrespective of the frame of reference (see, Luce *et al*, 1971; Stevens, 1951). It would therefore, enable the users of this information to make more credible economic decisions, given that the information they are using is empirically verifiable.

Financial statements are prepared on the premise that accounting is a measurement discipline. According to the IASB (2006, Para 83), an item that meets the definition of an element of financial statements should be recognized if it has a cost or value that can be measured with reliability. This implies that the information contained in financial statements is measurement information. This also suggests that it is not possible to prepare financial statements in the absence of principles of measurement.

The IASB framework (2006) for financial reporting is currently a statement of interrelated objectives and theoretical principles, providing reference for the underlying accounting discipline. It establishes the basis for determining which events should be reported, how they should be measured and the format in which they should be communicated to users (see, Hemus *et al*, 2000). This creates the impression that the information contained in financial statements has characteristics that are consistent with the principles of measurement. However, as noted above, accounting research has not succeeded in creating a theory of accounting measurement from the observation of accounting measurement practices. This casts doubt on the assertion that accounting is a measurement discipline. If accounting is not a measurement discipline, incorrect inferences might be drawn from the information in financial statements, on the premise that accounting information is measurement information. Such incorrect inferences would affect the economic decisions made by users. If users were aware of whether or not the concept of measurement in accounting is in harmony with the principles of measurement, it would assist them in drawing inferences from and understanding the true nature of accounting information.

According to Mautz and Sharaf (1961:15), auditing is concerned with verification, the examination of financial data for the purpose of judging the faithfulness with which they portray events and conditions. These authors also argue that verification requires the application of techniques and methods of proof. This suggests that the existence of the audit function rests on the premise that information can be empirically verified. It can also be inferred that the employment of techniques and methods of proof during the auditing of accounting information can only provide evidence of representational faithfulness if the accounting information is objective. It follows that the audit function verifies whether the information in financial statements is objective. According to Decoene *et al.*, (1995:238) measurement is applicable to objectively existing entities. This suggests that all measurable phenomena are objectively determinable entities. Establishing whether or not accounting is a measurement discipline thus also

provides evidence of whether or not accounting information can be empirically verified and whether this information is reliable.

## 1.5 Beneficiaries of this research

The following users of financial statements could benefit from this research:

- *The accounting profession:* As far as the author is aware, there is no prescribed theory of accounting measurement in general use. Therefore, knowledge of whether the accounting concept of measurement is in harmony with the principles of measurement would help identify the exact cause of the measurement problem in accounting. If current accounting practices are in harmony with the principles of measurement, it would imply that efforts should be concentrated on developing a theory of accounting measurement from current accounting practice. But if this is not the case, it would imply that efforts should be concentrated on developing accounting practices that are in harmony with the principles of measurement, ones from which a theory of accounting measurement can be developed. Furthermore, such knowledge helps to determine whether accounting is appropriately classified as a measurement discipline, or whether a new classification is required.
- *Chartered accountants in practice:* Chartered accountants in practice are arguably the largest group of people who possess the highest accounting professional qualification who deal with the measurement issues in the preparation of the financial statements. Currently, accounting is considered to be a measurement discipline (Vorster *et al*, 2008; IASB, 2006; Wolk *et al*, 2001). This suggests that accountants believe that they are providing accounting measurement information in their financial statements. Therefore, knowledge of whether or not the accounting concept of measurement is in harmony with the principles of measurement informs practising accountants of the true measurement position of current accounting practice. Such knowledge would identify any need to modify

- current accounting practices to make them compatible with the principles of measurement, to reclassify accounting practices as something other than practices of measurement, or to leave them as they are. Accounting measurement is dependent on the intuition of the accountant (Mattessich, 1964:79). This means that accounting measurements are dependent on the opinion of the accountant. Consequently, new information on accounting measurement would also raise awareness among accountants about the need for accounting practices to comply with the principles of measurement if accounting is to be considered a measurement discipline.
- *The auditing profession:* This research also benefits auditors. According to Soltani (2007:4), auditing is the process of providing assurance about the reliability of the information contained in financial statements. This means that the purpose of auditing is to verify whether accounting information is objective. Information is objective if it can be empirically verified: it may be verified if there is a standard against which it can be compared. This means that auditors need some standard against which to compare accounting information. Accounting is currently considered to be a measurement discipline (IASB, 2006; Wolk *et al.*, 2001). It is evident, then, that accounting information is compatible with the principles of measurement. All processes of measurement must have a standard against which they can be compared (Ryan *et al.*, 2002). It is clear from this that it is to be expected that there are standards against which accounting measurements can be compared. However, currently there are no standards for such comparisons (Chambers, 1997). It seems that the auditing profession cannot provide adequate assurance about the objectivity of the financial statements from the measurement perspective to users of the financial statements. Therefore, knowledge of whether or not the accounting concept of measurement is in harmony with the principles of measurement would inform practising auditors of the true measurement position of current accounting practice. They would thus be able to reassure users from a measurement perspective.

- *All users of financial statements:* Currently, accounting literature (Chambers, 1997; Ryan *et al.*, 2002; Willet, 1987) points out that the foundations of accounting measurement are not clearly stated in the accounting literature. This research proposes a way forward in the establishment of the foundations of accounting measurement. Such foundations would provide a standard against which accounting measurements could be compared. The establishment of such standards would enhance the reliability of accounting information provided to users.

## 1.6 Hypothesis

It has been noted earlier (e.g., AICPA, 1941; Bierman, 1963; IASB, 2006; Kirk, 2005) that current accounting literature contends that accounting is a measurement discipline. It follows, then, that the concept of accounting measurement would exhibit the properties of a true measurement discipline in its category.

On the other hand, there is also consensus (e.g. Gilman, 1939; Ijiri, 1975, 1967; Littleton, 1953; Staubus, 2004, 1985), from the observation of accounting measurement practices that the discipline of accounting has not succeeded in creating a theory of accounting measurement. Yet, every process of measurement must have a theory of measurement (Ryan *et al.*, 2002). This suggests that the accounting concept of measurement is not in harmony with the principles that establish measurement in social sciences. If the lack of success of the accounting discipline in creating a theory of accounting measurement suggests that the concept is not in harmony with representational measurement principles, the question to be answered is why accountants continue to refer to accounting as a measurement discipline. It could be that they are not familiar with the principles of measurement and, as a result, believe that whatever numerical assignments they make, they are measuring. It should also be pointed out that financial reporting is regulated by statute. In South Africa, for example, the format and content of company financial statements is prescribed by the Companies Act



of 1973, more specifically by the Fourth Schedule thereof, and statements of Generally Accepted Accounting Practice that are published by the South African Institute of Chartered Accountants (Benade, Hennings, Du Plessis, Delpont, De Koker and Pretorius, 2006:205). It is thus clear that accountants are forced by statute to follow certain numerical assignments that are prescribed by the South African Institute of Chartered Accountants, even though they do not regard these assignments as measurements. Consequently, it may be that the reason accountants refer to accounting as a measurement discipline is because of statutory requirements, otherwise they would not be referring to accounting as a measurement discipline.

It should be pointed out, however, that accounting research that has aimed to create a theory of accounting measurement from the observation of accounting practices (e.g. Gilman, 1939; Ijiri, 1975, 1967; Littleton, 1953; Staubus, 2004, 1985) has spanned over six decades. This suggests a firm belief that there is some form of measurement taking place in accounting practice. It also indicates that if this is not the case, accountants are not yet aware of this. If they were, they would not be trying to create a theory of accounting measurement from the observation of accounting practice itself.

The discussion in this section points out that accounting is currently considered to be a measurement discipline that does not have a theory of measurement, despite the fact that every measurement process should be underpinned by such a theory. This assertion is certainly contrary to the principles of measurement.

Therefore the hypothesis of this study is that the accounting concept of measurement is not in harmony with the principles of the representational theory of measurement, and accountants are not aware of this.

## 1.7 Purpose of the study

In order to address the research problem in an organized and systematic manner, the following research objectives have been formulated:

- To determine whether the accounting concept of measurement is in harmony with the principles of the representational theory of measurement
- To determine whether accounting is a measurement discipline as suggested by the accounting literature
- To investigate whether chartered accountants are aware that accounting is a measurement discipline or not
- To propose new areas of future research to address the problem of accounting measurement
- To develop a conceptual model of the problem of accounting measurement
- To propose a scientific model of the problem of accounting measurement
- To propose a scientific model of a solution to the accounting measurement problem

## 1.8 Research methodology

### 1.8.1 Research methods and techniques

According to Cooper and Schindler (2003), a research methodology consists of a set of methods for acquiring, defining, classifying and verifying knowledge. Four research methods were used in this study:

1. *Literature survey*: A critical analysis of the literature was conducted. The results of this critical literature analysis are reported throughout the thesis. The purpose of such an analysis is discussed in chapter 2.
2. *The identification of the principles of measurement from literature*: The principles of the representational theory of measurement were identified from the literature survey as the principles that establish measurement in the social sciences. As accounting is a social science, it was decided that these principles should be used to establish whether or not the accounting

- concept of measurement is in harmony with the principles of measurement (see chapter 2).
3. *The application of representational theory of measurement to accounting:* The representational theory of measurement was also compared to the accounting concept of measurement. The results are reported throughout this thesis.
  4. *Empirical research:* A questionnaire was sent out to chartered accountants. The development of the questionnaire is outlined in chapter 11. The results of the questionnaire are reported in chapter 12.
  5. *The systems view of problem solving:* The model for problem solving that was designed by Mitroff, Betz, Pondy and Sagasti (1974:48) was used in this study to analyse, among other things, the problem of establishing whether the accounting concept of measurement is in harmony with the principles of the representational theory of measurement (see chapter 13).

### 1.8.2. Literature survey

In conducting this research a critical analysis of relevant literature was conducted. This literature survey spanned several disciplines, including accounting, management accounting, finance, mathematics, physical sciences, strategic management, philosophy and psychology. The role of the literature survey in each discipline is explained below as follows:

- **Accounting**-The survey of the accounting literature helps the researcher to understand the accounting environment in which the principles of measurement are applied. It also helps to understand the current measurement beliefs in accounting. According to Stevens (1951:1), measurement is a preoccupation of psychophysics. This means that all measurements must be evaluated in relation to the environment in which they have been created. It is thus necessary to understand the accounting environment first, before the evaluation of accounting measurements. The accounting literature (IASB, 2006) points out that the objects of

measurement in accounting are cost and value. It is therefore necessary to understand cost and value before it can be established whether these two are measurable.

- **Management Accounting-** According to Ijiri (1975: ix), accounting is also considered to be a system for providing information that is useful for making economic decisions. Since management accounting deals with the provision of information for making economic decisions, a survey of the literature on management accounting must be conducted.
- **Finance-** The survey of finance literature informs the study on the concept of value. This concept is one of the subjects of measurement in accounting. According to Caws (1959:3), measurement presupposes something to be measured, and, unless we know what that something is, no measurement can have any significance. This means that it is necessary to fully understand the concept of value before evaluating measurements of value. As the concept of value has its applications in finance, to understand this concept and its uses, one needs to study finance literature.
- **Mathematics-**The concept of measurement is a mathematical concept (Stevens, 1951). This means that the principles of measurement lie in mathematics. In order to understand the concept of measurement it is necessary to survey the mathematical literature on measurement. Luce *et al.* (1971) recommend that in order to understand the principles of representational measurement, mathematical material on sets, relations, functions, probability, topology, abstract algebra and calculus must be thoroughly grasped. This study was undertaken after a thorough review of the relevant literature. In section 1.3 it was noted that the accounting discipline has not managed to create an acceptable theory of accounting measurement. Ryan *et al.* (2002) point out that every process of measurement must have an underlying theory of measurement. This

indicates that the principles of mathematics are not being employed adequately in accounting.

- **Physical Sciences**-The concept of measurement originated as classical measurement that occurs in the physical sciences. The representational theory of measurement that is discussed in this study is applicable to both the physical and the social sciences, and the source of classical measurement is in the physical sciences. Consequently, a survey of the physical science literature on classical measurement must be conducted in order to fully understand the representational theory of measurement.
- **Strategic Management**-Strategic management utilizes information for decision-making. The concept of pragmatics in measurement refers to how measurement information is used (Stevens, 1951). In measurement theory (Stevens, 1951) the meaningfulness of measurement information is also dependent on its uses. Accounting research has indicated that there are limitations in accounting information as far as usefulness is concerned. These limitations have been elaborated upon extensively in the financial literature (see Evans 2003; Francis and Schipper 1999; Lev and Zarowin, 1999; Sterling 1997). This suggests that the measurement concept of meaningfulness is not being employed adequately in accounting. It is thus necessary to study strategic management in order to understand the pragmatic meaningfulness of measured accounting information.
- **Psychology**-The concept of representational measurement was initially developed for psychologists (Stevens, 1946; 1951). Mathematical psychologists (Luce *et al.*, 1971; Scott and Suppes, 1958) modelled the principles of representational measurement on the measurement of psychological phenomena. It follows that in order to fully understand the application of principles of representational measurement to social sciences, then it is necessary to study the applications of the theory to psychology. In addition, accounting measurements are also dependent on the intuition of accountants (Mattessich, 1964). Accounting measurements are thus influenced by the psychological state of the accountant.

Consequently, mathematical psychology literature on representational measurement must also be studied.

- **Philosophy-** The philosophy discipline is fundamental to accounting practice. According to Flanders (1961), accounting studies derive their basic meaning from learning philosophy. In order to understand the accounting concept of measurement it is therefore necessary to study the philosophy of this concept of measurement.
- **Quantum Physics-** According to Goldberg (2001), accounting activities are assumed to flow into a business. It can be argued that accounting activities possess both momentum and position. Bohmn (1980) remarks that the laws of quantum mechanics indicate that it is impossible to measure both position and momentum: one measures one or the other. The laws of quantum physics are based on the observation of reality. Consequently, if accounting phenomena are believed to be in motion, one may argue that since accounting events are real, in order to understand the concept of flow in accounting, one must understand the principles of quantum physics.

### **1.8.3.The identification of the principles of measurement**

In section 1.1 it was noted that accounting is a social science. This means that in order to determine whether the accounting concept of measurement reflects the characteristics of a true measurement discipline one must compare the characteristics of this concept with the characteristics of a theory of measurement that establishes measurement in social scientific disciplines such as accounting. The principles of the representational theory of measurement are used to achieve this purpose. This theory of measurement was designed to establish measurement in both the social sciences and the natural sciences (Luce *et al.*, 1971; Luce, *et al.*, 1990; Luce *et al.*, 1989). These three volumes outline the principles of representational measurement comprehensively. Luce *et al.* (1990:323) recommend that in order to determine whether a particular variable is measurable, a detailed empirical and theoretical analysis of the relevant

phenomena must be made. They assert that during the process of analyzing the phenomena, the theory of measurement can help clarify the status of different numerical assignments. Consequently, the opinion in this study is that the application of the representational theory of measurement to the qualitative structures of accounting phenomena should reveal whether or not different numerical assignments in accounting are in harmony with the principles of representational measurement.

### **1.8.3.1 The application of the principles of measurement**

The application of the principles of measurement to accounting is not a new idea. For over four decades, accounting researchers (e.g., Chambers, 1960, 1997; Ijiri 1965; Orbach, 1978; Staubus, 1967; Vickrey, 1970; Vollmer, 2007; Willet, 1987, 1988) have applied the principles of measurement to accounting in a bid to formulate the foundations of accounting measurement. However, these studies applied mainly the principles of classical measurement that occur in the physical sciences. None of the previous studies used the principles of the representational theory of measurement to establish whether the accounting concept of measurement reflects the characteristics of a true measurement discipline. This is because the application of these principles to social science is a relatively new area that is still under development (see Luce, 1996) and these studies were not aware of this theory. The present study applies the principles of representational measurement to determine whether or not accounting is a true measurement discipline. Orbach (1978:13) regards the application of the principles of measurement to accounting concepts as theoretical research. Vickrey (1970) holds the same view. For this reason this researcher considers the application of these principles to accounting concepts of measurement made in this study to be theoretical research.

#### **1.8.4 Empirical study**

In order to test whether or not members of the South African Institute of Chartered Accountants are aware that accounting is not a measurement discipline, an empirical study was conducted. For this purpose, a questionnaire was compiled following a thorough and critical analysis of the literature (see chapter 11). The aim of the questionnaire was to investigate whether chartered accountants in South Africa are familiar with the application of the concept of representational measurement to accounting. The questionnaire was sent to chartered accountants who are members of the South African Institute of Chartered Accountants. The results of the questionnaire are presented in chapter 12.

#### **1.8.5. The systems view of problem solving**

The aim of this study is, among other things, to determine whether the accounting concept of measurement is in harmony with the principles of the representational theory of measurement. The model for problem solving designed by Mitroff *et al* (1974:48) was used to better understand the measurement problem in accounting. This model involves a systemic view of problem solving. According to Mitroff *et al.* (1974), a systematic approach to problem solving includes conceptualization, modelling, model solving and implementation. This study uses the Mitroff model to help conceptualize, identify and solve the measurement problem in accounting. The model is discussed fully in chapter 2.

### **1.9. Chapter layout**

#### **Chapter 2 Research Methodology - The principles of the representational theory of measurement**

This chapter outlines part of the research methodology that is used in this study. The other part (questionnaire survey) of the research methodology is outlined in chapter 11. The principles of the representational theory of measurement are outlined and discussed in this chapter. These principles will be compared to the



accounting concept of measurement in order to determine whether this concept is in harmony with the principles of the representational theory of measurement.

### **Chapter 3 Representational measurement and the goals of accounting**

In chapter 3 the author discusses whether the goals of financial reporting are in harmony with the principles of the representational theory of measurement. The concept of measurement presupposes the achievement of a goal. Measurement theory points out that this goal must be achieved to be in harmony with the principles of measurement, and for measurement to have any significance.

### **Chapter 4 The concept of a scale in accounting measurement**

This chapter introduces the concept of the scale to the study. This concept is fundamental to all measurement disciplines. A discussion that evaluates whether the concept of a scale is properly applied to the accounting discipline is included.

### **Chapter 5 Representational measurement under the going concern assumption**

All measurements occur at a particular point in time regardless of what has happened before or what will happen afterwards. Yet the accounting concept of measurement asserts that the magnitudes of accounting measurements under the going concern concept are dependent on subsequent events. This chapter questions the possibility of having representational measurements whose magnitudes are dependent on future events.

## **Chapter 6 Measuring the values of accounting phenomena: an empirical challenge**

Chapter 6 comprises a discussion of whether value is measurable under the representational theory of measurement. It also questions whether the amount of monetary units paid to acquire a commodity is a measure of the value of a commodity.

## **Chapter 7 Objectivity and the accounting concept of measurement**

All measurements are intended to be objective. This means that accounting measurements are also expected to be objective. The focus in this chapter is on evaluating whether accounting practices can be considered objective under the representational theory of measurement.

## **Chapter 8 Representational measurement and the concept of relativism in accounting**

This chapter focuses on the relative nature of accounting practices of measurement. In particular, the chapter discusses the framing activities of these practices and the effects of the various sources of relativism on the accounting concept of measurement, namely the effects of cognitive, cultural, linguistic and contractual relativism.

## **Chapter 9 Representational measurement and the presentation of financial statements**

The theme in this chapter is whether financial statements are presented in a way that is in harmony with the principles of the representational theory of measurement. The focus includes whether the accounting concept of performance measurement is in harmony with the principles of representational measurement.

## **Chapter 10 The meaningfulness of accounting information**

The concept of meaningfulness is fundamental to all measurement information. This chapter analyzes whether accounting information can be considered meaningful.

## **Chapter 11 Empirical research design, methods and techniques**

The role of this chapter is to report on the research design, methods and techniques used in the empirical study, which includes the use and analysis of a questionnaire. The application of the principles of the representational theory of measurement to accounting is also discussed. The role of the empirical research is also discussed in this chapter.

## **Chapter 12 Research results**

In this chapter the author reports on the results of the literature review and of the questionnaire.

## **Chapter 13 Towards a model of accounting measurement**

This chapter presents the main contributions of this thesis, namely, the identification of the variables that underlie the measurement problem in accounting, and the identification of characteristics that make accounting a measurement discipline.

## **Chapter 14 Conclusions and future work**

In this chapter a summary of the previous chapters is provided and directions for future work in this area are discussed. The remainder of the dissertation comprises various appendices and a bibliography.

## Chapter 2-Research Methodology - The principles of the representational theory of measurement

### 2.1 Introduction

Measurement theory and the representational theory of measurement have a critical role to play in the social sciences. The need for measurement in the social sciences and the considerable difficulty in applying the principles of fundamental measurement gave rise to the creation of the representational theory of measurement, a theory that establishes measurement in the social sciences. In chapter 1 it was established that accounting is considered to be a measurement discipline. It was also noted that accounting principles are considered to be social scientific principles. This suggests that the principles of measurement that are applicable to accounting are the principles of the representational theory of measurement.

Chapter 1 highlighted the fact that, from observing accounting practices of measurement, accounting researchers have not succeeded in creating a theory of accounting measurement. Luce *et al.* (1971) point out that every process of measurement must have an underlying theory of measurement. This has given rise to the belief in this study that the accounting concept of measurement might not be in harmony with the principles of the representational theory of measurement that has established measurement in the social sciences.

The principles of the representational theory of measurement are used in this study to identify the nature of the measurement problem in accounting. These principles, which are referred to as the principles of modern measurement theory, are comprehensively outlined in the three volumes of the “Foundations of Measurement” (Vol. 1, 2 and 3) by Luce, Krantz, Suppes and Tversky (1971, 1989, 1990). According to Luce and Narens (1994), the representational theory of measurement began largely as a way of understanding the source of physical measurement. The history of this can be traced as far back as Helmholtz (1887)

and Holder (1901). But as time has moved on, the representational theory of measurement has greatly generalized the understanding of the scope of measurement possibilities and has provided increasingly useful applications to the behavioural and social sciences (Luce, 1996:95). It is these applications to the social sciences that are of fundamental importance to this study. Luce *et al.* (1990) recommend that the principles of the representational theory of measurement be used to establish whether or not a particular numerical assignment is a process of measurement. This recommendation is employed in this study to establish whether the numerical assignments in accounting are processes of measurement.

It was noted in chapter 1 that the accounting concept of measurement lacks a theory of measurement and a precise specification of the foundations of measurement. The theory and foundations of measurement form the backbone of a measurement discipline. It is therefore necessary to establish whether the accounting concept of measurement has the qualities of a true measurement discipline in accordance with established measurement principles. The purpose of this chapter is to discuss part of the research methodology used in this study to establish this. A discussion of the empirical research is also provided in chapter 11.

This chapter commences with a discussion of the research methods in section 2.2 and its subsections. The definition of measurement is discussed in section 2.3, followed by a discussion of the sources of representational measurement in section 2.3.1. A brief history of the representational theory of measurement is presented in section 2.4. The principles of representational measurement are outlined in section 2.4.1 and its subsections. A discussion of the application of this is provided in section 2.5, followed by a discussion of the weaknesses of the theory in section 2.6. The chapter is concluded in section 2.7.

## 2.2 Research Methods

### 2.2.1 Analysis of the trends in current and previous research into accounting measurement

It was mentioned earlier (see, chapter 1) that the application of the principles of measurement to accounting is not a new idea. There is a great deal of literature on the concept of measurement in accounting. The trends in this literature indicate that there has been very little development in accounting measurement methodology: history indicates that there have been considerable methodological disputes. Early researchers into accounting measurement, such as Gilman (1939), Littleton (1953) and Paton and Littleton (1940), believed that accounting practices were practices of measurement without a theory to back them up. The focus of these studies was on cataloguing accounting practices of measurement and attempting to find common points among them. However, these studies did not succeed in establishing either the common points or the phenomenon that was being measured. The view of these early studies mentioned above is one that is held by accountants even today. For example, Wolk *et al.* (2001) and the IASB framework (2006) for financial reporting still consider accounting to be a measurement discipline even in the absence of a theory of accounting measurement. This suggests that the perspectives of the accounting concept of measurement have not changed over the past sixty years.

In the 1960s authors such as Chambers (1960), Ijiri (1965), Ijiri and Jaedicke (1966), McDonald (1967) and Staubus (1967) realized that the accounting concept of measurement produced measurements that were not objective. These studies attempted to base the accounting concept of measurement on a system of axioms, but without success. However, these studies still considered accounting to be a measurement discipline even in the absence of specified foundations of measurement. Furthermore, they did not specify the theory of measurement on which the numerical assignments in the accounting discipline were based. Moreover, these studies failed to establish the cause of the lack of objectivity of accounting measurements. These studies neither catalogued the accounting

practices prevalent at the time nor did they attempt to establish a theory of accounting measurement from accounting practices. The attempt to formulate axioms on which to base accounting measurement suggests that these authors believed that there were no bases of measurement in accounting and as a result they needed to formulate these bases. This also indicates a change in the methodological perspective of accounting researchers. Current accounting literature (IASB, 2006; Staubus, 2004; Vollmer, 2007; Wolk *et al.*, 2001) have also failed to specify the foundations of accounting measurement. This further underlines the reality that the problems that the accounting discipline attempted to solve over forty years ago have yet to be explained.

Vickrey (1970) questioned the status of accounting as a measurement discipline. He applied the principles of fundamental measurement that are encountered in the natural sciences to evaluate whether accounting is a measurement discipline. He argued that for accounting to be a measurement discipline, it is necessary to find an extensive accounting property. Since all extensive measurements are additive (Luce *et al.*, 1971) this indicates that all accounting measurements must be additive. This viewpoint suggests that measurement can only occur in accounting once an extensive accounting property has been found. However, accounting is a social science, and the principles of measurement that are applicable to natural sciences are not applicable to social sciences. Luce *et al.* (1971) pointed out that the existence of an extensive property is not a prerequisite for measurement to occur in the social sciences. There are some structures such as conjoint and difference measurement in which non-extensive measurement occurs. To date, no research has been conducted in accounting to establish whether or not accounting measurements are extensive measurements. However, accounting literature (e.g. IASB, 2006; Kirk, 2005; Vollmer, 2007; Wolk *et al.*, 2001) recommends that accounting measurements should be added to financial statements. It is clear then, that an extensive property is still being considered as fundamental to accounting measurement. Almost forty years on, this view has not changed.

Ijiri (1975) attempted to develop an axiomatic theory of accounting measurement. He developed this “theory” without specifying either what attribute was being measured or a scale of measurement. This was the last major attempt by an accounting researcher to create a theory of accounting measurement. An analysis of Ijiri’s work reveals that he confused measure theory with measurement theory. Measure theory does not require the specification of the attribute that has to be measured, while measurement theory does. In this case, Ijiri developed a measure theory of accounting and not an accounting measurement theory. Authors also such as Staubus (1985), Chambers (1997), Walker and Jones (2003) and Staubus (2004) also noted that there are no specified attributes that can be measured in accounting. Vollmer (2006, 2007) and McLean (2006) also highlight the current lack of foundations in accounting measurement. This analysis shows that from 1939 to date there has been no progress in the development of the foundations of accounting measurement. The problems that existed then in accounting are those that exist now. Successive research has not built on past studies. These researchers all show a conflicting understanding of accounting measurement. It is thus clear that there is currently no methodological rationale that can be justified in integrating accounting research on measurement. For this reason, the focus of this study is on conducting a foundational analysis of accounting measurement by comparing the principles of accounting measurement to those of the representational theory of measurement. Table 2.3 summarizes previous and current research in accounting measurement.

**Table 2.3 Previous and current research in accounting measurement**

<b>Year</b>	<b>Researcher</b>	<b>Nature of the accounting measurement research</b>
1939	Gilman	Discussed the concept of measurement in relation to the prevailing accounting practices. He made attempts to establish a theory of accounting measurement from prevailing accounting practices. He did not attempt to give a precise definition of the objects that are subject to measurement in accounting. These objects have been identified as cost and value by the accounting literature.
1940	Paton & Littleton	They attempted to produce a theory of accounting measurement from the observation of accounting practices of measurement. This study did not





		attempt to give a precise definition of the properties being measured. Furthermore, their study did not attempt to define value or cost, or to give an empirical identity to cost or value.
1953	Littleton	He attempted to induce a theory of accounting measurement from the observation of accounting practices, but he did not identify the attributes that were being measured by the practices he was observing. It is not clear from his study whether it was cost or value that was being measured.
1960	Chambers	He discussed the view that accounting measurement does not necessarily lead to the presentation of relevant information in financial statements. The gap in his study is that he does not define precisely what is being measured in accounting. The study does not discuss whether or not the measurement of cost or value provides relevant information to financial statements.
1965	Ijiri	He made attempts to develop an axiomatic theory of accounting measurement. His axiomatic theory was not based on the properties of cost or value. Whether or not the axioms created in this study represent the true properties of cost or value cannot be verified.
1966	Ijiri & Jaedicke	They discussed the reliability and objectivity of accounting measurements. The study argued that accounting measurements are not reliable or objective. The study does not highlight whether the measurement of cost or value leads to subjective measurements.
1967	Staubus	He discussed current cash equivalent as a possible measure of the value of an asset. Discussed the credibility of asset measurement methods prevailing at the time.
1967	McDonald	He discussed the feasibility criteria for accounting measures. He focused on what is measurable in accounting and what is not. He failed to establish what is measurable in accounting apart from monetary units or whether cost and value are measurable.
1970	Vickrey	He questioned the status of accounting as a measurement discipline. He concluded that there is no property that is currently measured in accounting apart from the numerosity of monetary units. This study indicated that at that particular point in time it was not possible to determine whether cost and value are measurable.
1975	Ijiri	He made attempts to develop a theory of accounting measurement. However, he used the principles of measure theory instead of measurement theory. The study failed therefore to specify a theory of accounting measurement.
1985	Staubus	He made attempts to induce a theory of accounting measurement from the observation of accounting practices of measurement.
1985	Tinker	He discussed the various theories of value (e.g. Marginalist, Canonist value theory, mercantilist value theory). The study concluded that value is an ambiguous concept that is not empirically testable. He also concluded that accountants do not have a precise definition of cost or value. That is, there are no foundations for measuring cost or value.



1997	Chambers	He revealed that there are no foundations of accounting measurement.
2003	Walker & Jones	They discussed a possible way forward in accounting measurement. They considered possible attributes of accounting phenomena that are measurable. However, cost or value was not established as one of the measurable attributes in accounting.
2004	Staubus	He discussed the prevailing views of accounting measurement. He attempted to establish the central ideas of accounting measurement. His attempts focused on finding the attributes of accounting phenomena that are measurable but he failed to establish this.
2006	Vollmer	He discussed the meaning of financial numbers to users. He concluded that their meaning is relative to the user. The concept of meaning depends on what the user wants to draw from the numbers. The study suggests that the meaning of cost or value measurement is relative to what the user wants to infer from the measurement.
2006	McLean	He proposed new concepts of measuring value. However, the research does not provide a precise definition of value. The study does not mention whether or not cost is measurable.
2007	Vollmer	He investigated various ways in which numbers are involved in the ordering of activity in social situations. He concluded that accounting numbers are relative to a specific frame of reference. The study therefore suggests that the measurement of cost or value in accounting is relative to social situations.

### 2.2.2 Normative research

The representational theory of measurement describes and sets the standards or rules that measurement in the social sciences should follow. The rules of measurement set by this theory validate whether a particular numerical assignment in social science can be described as a measurement. Luce *et al.* (1990:325) recommend that the principles of the representational theory of measurement should be used in deciding whether a particular numerical assignment to a phenomenon in social sciences is a process of measurement. They point out that for the representational theory of measurement to be used in the process of validating a numerical assignment, a detailed empirical and theoretical analysis of the phenomenon that is being measured must first be conducted. During the process of analyzing the phenomenon, the theory of representational measurement can help clarify the status of the numerical assignment and whether it is a measurement or not. These recommendations are discussed below as follows:

- A detailed empirical and theoretical analysis of the phenomenon that is being measured must be conducted. This ensures that the object of measurement is appropriately understood prior to measurement. This gives clarity as to the exact identity of the property of the object that is being measured (see section 2.4.1.2).
- During the process of analyzing the phenomenon, the theory of representational measurement can help clarify whether the numerical assignment is a measurement or not. This procedure helps to clarify whether the methods employed in measurement are compatible with the characteristics of a true measurement discipline.

This highlights the fact that the representational theory of measurement creates the norm or the code of behaviour that numerical assignments in the social sciences could follow if they are to be considered measurements. In this study, the principles of the representational theory of measurement are used to establish

whether the numerical assignments in accounting can be considered measurements. For this reason, this research methodology is considered normative. The reality problem identified as a result of the application of the representational theory of measurement is analyzed by means of the Mitroff model. The Mitroff model is discussed in section 2.2.8 below and the results of the normative research are analyzed in chapter 13.

### **2.2.3 Perspectives of research methodology**

There are three distinguishable levels of the methodological dimension of research, namely methodological paradigms, research methods and research techniques. According to Mouton (1998) methodological paradigms are the most abstract level and they include the distinction between qualitative and quantitative techniques. Research methods are those that are used at certain stages of the research process, for example sampling, data collection and data analysis. Research techniques represent the most concrete level of the methodological dimension and include specific techniques related to sampling, data collection and data analysis.

Other terms related to research methodology are research strategy and research design. Research strategy guides the research effort by defining the context within which it will be conducted. It also provides the link between the research objectives and research activities. Research strategy is partly derived from the methodological paradigm – qualitative or quantitative – that fits a particular research problem. Research design, on the other hand, is defined as a plan of how a research project will be conducted, specifying who or what is involved, and where and when it will take place (Duplooy, 2001). In other words, research strategy indicates which direction will be taken, while research design indicates what needs to be done while heading in that specific direction.

In this study, the research strategy includes an exploratory research strategy, a critical literature analysis, empirical research and the Mitroff *et al.* (1974) model for

problem solving. The research design employed in this study discusses whether or not it is necessary to control the variables that affect accounting measurement. A full discussion of the research strategy is carried out in the sections that follow in this chapter and the research design used in the questionnaire survey is given in chapter 11.

## **2.2.4 Research Strategy**

Recognized research methods are employed in this study, amongst others an analysis of existing data, namely, a literature survey and a questionnaire. A comprehensive literature analysis is undertaken and a questionnaire prepared from the statements formulated from the literature analysis is sent to members of the Institute of Chartered Accountants of South Africa. The principles of the representational theory of measurement that are used in this study are outlined in this chapter in the sections below.

## **2.2.5 Exploratory research**

Exploratory research is conducted when there is very little other research on a specific topic (Welman and Kruger, 2005). In chapter 1 it was established that the accounting researchers (e.g. Gilman, 1939; Ijiri, 1975, 1967; Littleton, 1953; Paton and Littleton, 1940; Sterling, 1966) have not succeeded in creating a theory of accounting measurement from the observation of accounting measurement practices. This suggests that accounting practices of measurement are pre-theoretical. It was also noted in chapter 1 that no previous study has applied the principles of the representational theory of measurement to accounting to determine whether the accounting concept of measurement is in harmony with the principles of the representational theory of measurement. No research has ever been conducted to establish whether accountants are aware of whether or not the accounting concept of measurement is in harmony with the principles of the representational theory of measurement. It was thus established that the principles of exploratory research are suitable for this study. Furthermore,

according to Cooper and Schindler (2003), the objectives of exploratory studies include collecting new data, developing hypotheses or questions for further research, clarifying concepts and establishing research priorities. This study collects new information about the application of the concept of representational measurement in accounting and it identifies new areas for further research in accounting measurement.

This study also aims to establish whether the reference to accounting as a measurement discipline (e.g. AICPA, 1941; Bierman, 1963; Wolk, *et al*, 2001) is appropriate. A natural result of this study is the identification of the shortcomings of the current approach in order to identify priorities for future research. In addition, the literature review has not managed to establish a study that used a questionnaire to test whether accountants are aware of whether the accounting concept of measurement is in harmony with the principles of the representational theory of measurement and their application. Therefore, it can be concluded that this study is exploratory.

### **2.2.6 Literature survey**

A thorough literature review is crucial to the success of a research project. According to Ryan *et al.* (2002), the success of the whole research project depends on the quality of this step. In this study a thorough literature analysis is conducted. The importance of a literature review, as outlined by Ryan *et al.* (2002), is discussed below. The comments of Ryan *et al.* (2002) are italicised:

- *A thorough review of relevant literature, and a process of refinement of the issues posed by the research problem is a crucial stage and the success of the project depends on this step.* In this study a thorough literature review indicated that the concept of measurement lies outside the accounting discipline. It is a concept whose principles lie in mathematics. It follows that answers to the research problem (the establishment of whether or not the accounting concept of measurement is in harmony with the principles of measurement) also lie in mathematics.



- *Literature review ensures that previous studies are not duplicated.* It was noted in chapter 1 that the application of measurement theory to accounting is not a new idea. Authors such as Chambers, 1997, Willet 1988 and 1987, Ijiri, 1975, and Vickrey, 1970 have applied the principles of measurement to accounting. However, none of the previous studies have applied the principles of the representational theory of measurement to determine whether the accounting concept of measurement is compatible with the principles of the representational theory of measurement or whether accountants are aware of whether or not the principles of representational measurement are in harmony with the principles of representational measurement.
- *To find the most recent and authoritative literature on the subject area.* The most authoritative literature on the representational theory of measurement was found to be the three volumes on *The Foundations of Measurement* by Luce *et al.* (1971, 1989, 1990). The principles of representational measurement applied in this study are based on these three volumes.
- *To discover what the most widely accepted empirical findings in the field of study are.* In chapter 1 it was noted that there is no prior research that has tested whether accountants are aware of whether the accounting concept of measurement is compatible with the principles of the representational theory of measurement. No study was found to have tested whether accountants are familiar with the principles of representational measurement and their applications.
- *To ascertain the most widely accepted definitions of key concepts in the field.* In this study it was noted that before the development of the representational theory of measurement, the concept of measurement did not have a precise definition. It was necessary to conduct a thorough literature review to establish an appropriate definition of measurement. The literature review was also necessary to find an appropriate theory of measurement applicable to the accounting discipline.

In order to conduct a thorough literature analysis one needs access to books, conference proceedings, journal articles (national and international), theses and dissertations. To find the relevant articles, searches were carried out using the electronic library of the University of Pretoria.

### **2.2.7 Empirical research**

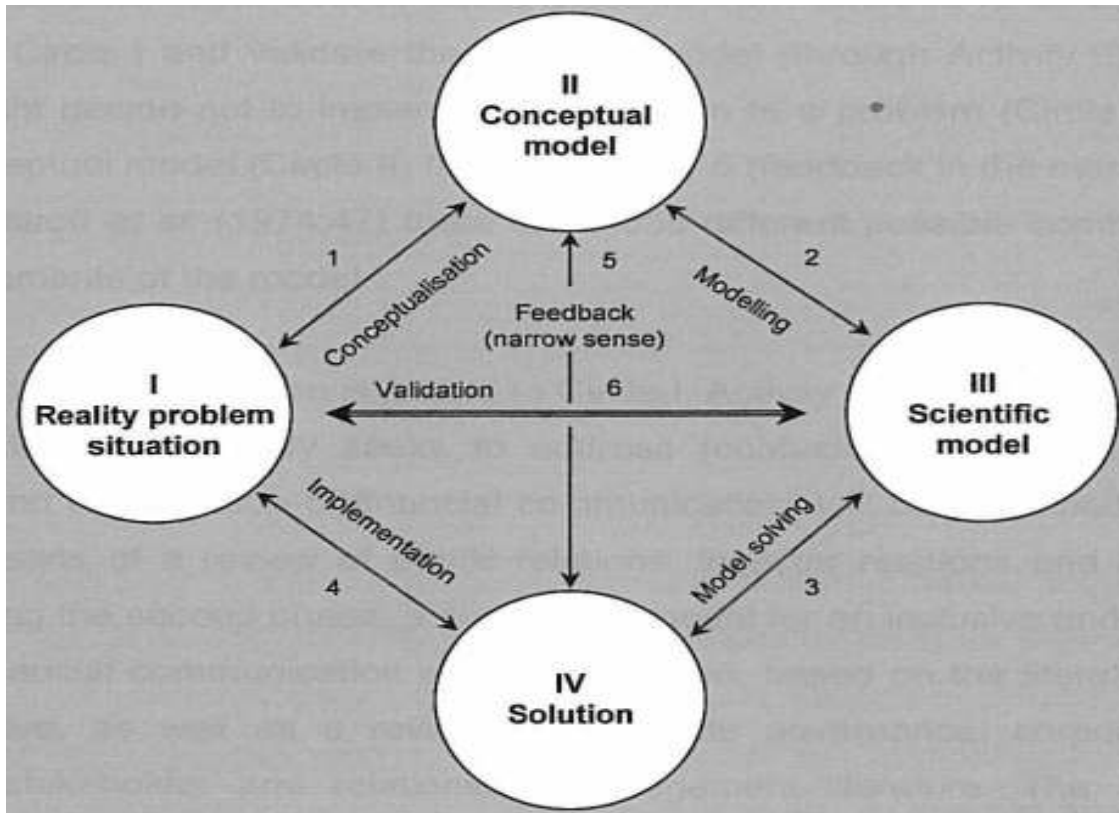
In order to investigate whether or not accountants are aware that the accounting concept of measurement is not in harmony with the principles of the representational theory of measurement, a questionnaire was developed in MS Word 2000 format. This questionnaire was aimed at members of the South African Institute of Chartered Accountants. Most questionnaires were sent by e-mail but some were hand delivered. The purpose of the study was set out on the cover page and the questionnaire followed on page 3. The sequence of events that was used to prepare, send and analyze the responses to the questionnaires is outlined in chapter 11.

### **2.2.8 The Mitroff Model**

In chapter 1 the Mitroff model (1974) was introduced to help explain the scope of this study. The scope of this thesis may be explained more specifically in terms of the model for problem solving designed by Mitroff, Betz, Pandey and Sagasti (1974). Koornhof (1998) used the Mitroff *et al.* (1974) model in an accounting thesis on the concept of “flexibility” and found it useful in providing legitimacy to an exploratory and non-formal research topic. The model is depicted in figure 2.1 below.



**Figure 2.1 A systems view of problem solving**



Source: Mitroff *et al.* (1974:48)

The model takes a holistic or systems view of different varieties of scientific activities. It has no definite beginning or ending. In terms of this model, research is seen as continuous. A research project could begin at any of the circles 1, 2, 3 or 4. That is, in relation to this study, the determination of whether the accounting concept of measurement is in harmony with the principles of the representational theory of measurement could begin at any point of the model. For example, a research project may start at Circle 1, with the identification of a problem situation. Since it was noted in chapter 1 section 1.3 that the problem in this study is the absence of a theory of accounting measurement, this suggests that this study could begin with activities that are aimed at discovering the reasons accounting researchers have not succeeded in creating a theory of accounting measurement. Activity 1 conceptualises the problem so as to develop a conceptual model in

Circle 2. In this study it would be necessary to conceptualise the measurement problem in accounting so as to develop a conceptual model of this measurement problem. According to Koornhof (2001), the conceptual model sets out in broad terms the definition of the particular problem that will be solved. It then specifies the field variables that will be used to define the nature of the problem and the level at which the variables will be treated. In this study this would entail the specification of the variables that affect the accounting concept of measurement. Currently, these variables are not known.

Activity 2 entails the formulation of the scientific model in Circle 3. According to Rivert (1972:9), a scientific model is a set of either qualitative or quantitative logical relationships which link together the relevant features of the reality with which we are concerned. This would require the specification of a scientific model of the measurement problem in accounting. It requires the identification of all the variables that affect accounting measurement and the relationships between them. A model of the variables that affect accounting measurement that is empirically testable would qualify as a specified scientific model.

The third phase would concern the performance of activity 3 to derive a solution from the scientific model while an implementation of activity 4 would entail feedback of the solution to the original problem situation. In validation activity 6 the degree of correspondence between reality and the scientific model may be evaluated. Finally, in activity 5, namely feedback in the narrow sense, problem-solving activities (Circles 2, 3, 4) are applied, with the goal being to derive better scientific solutions from the activities and elements in the model. Mitroff *et al* (1974:53) remarks that a single research project rarely covers all the circles and activities. Various combinations of circles and activities can be used. In this study this would entail the derivation of a solution to the measurement problem in accounting. This would involve the creation of a theory of accounting measurement and the specification of the foundations of accounting measurement. The testing of the created theory of accounting measurement

would follow, and then the evaluation of the feedback on the validity of the theory of accounting measurement.

The research for this dissertation is limited to Circle 1, Activity 1, Circle 2 and partly Activity 2. In the first phase, the problem this study seeks to address is discussed.

The problem in this study is determining whether the accounting concept of measurement is in harmony with the principles of the representational theory of measurement and whether or not members of the South African Institute of Chartered Accountants are aware of whether or not the current accounting concept of measurement is in harmony with the principles of the representational theory of measurement. This is done by a review of the literature on accounting measurement and by comparing the current accounting practices with the principles of the representational theory of measurement. In order to establish whether members of the South African Institute of Chartered Accountants are aware of whether or not the current accounting concept of measurement is in harmony with the principles of the representational theory of measurement, a questionnaire is used. In phase 2 of the Mitroff *et al.* (1974) model a conceptual model of the real problem is developed. This defines the problem to be solved in broad terms and specifies any field variables that will be used to define the nature of the problem. In this thesis, this involves the identification of the perspectives surrounding the measurement problem in accounting. A discussion of the application of the Mitroff *et al.* (1974:53) model to problem solving in analysing the results of this study is provided in chapter 13.

In chapter 3 the reality of the problem situation is described by means of a review of the implications of the principles of the representational theory of measurement on the definition and the objectives of accounting. The chapter also discusses the current application of the principles of representational measurement to accounting. An analysis is also carried out in chapter 3 of the use of the principles of measurement in accounting with particular reference to whether the definition and objectives of accounting are in harmony with the principles of the

representational theory of measurement. The problem situation entails three interrelated shortcomings of the current application of the principles of representational measurement to accounting:

- The intuition that accounting phenomena can be represented numerically is pre-theoretical
- The chartered accountants are oblivious to the idea that physical indices of accounting phenomena are not measurements
- The lack of foundations for accounting measurement

In chapters 4, 5, 6, 7, 8, 9 and 10 a further description of the reality problem situation is given and a theoretical justification for the need to develop foundations for accounting measurement is provided. This is done by a review of whether current accounting practices are in harmony with the principles of the representational theory of measurement. In chapter 13, a conceptual model of the research problem and a proposition for a scientific model of the research problem is developed, based on the content of chapters 2,3,4,5,6,7,8,9,10 and 12.

Therefore, from the theoretical perspective, Circle 1, Circle 2 and part of Circle 3 of the Mitroff *et al.* (1974) model would have been covered. The purpose of the questionnaire survey is to supplement the theoretical component. The research design, methods and techniques for the questionnaire survey is discussed fully in chapter 11. Survey research is therefore used in this study:

- To find out whether members of the South African Institute of Chartered Accountants are aware of whether or not the accounting concept of measurement is in harmony with the principles of the representational theory of measurement.

Finding out whether accountants are aware of the current status of accounting as a measurement discipline helps in determining where the accounting measurement problem really lies. If chartered accountants are aware of whether or not accounting is a measurement discipline this would help determine whether or not chartered accountants have adequate measurement knowledge to prepare

financial statements. It would also help in re-evaluating the accounting education of chartered accountants. It might be necessary to introduce the principles of measurement into the accounting curriculum.

### **2.3 The definition of measurement**

A review of the literature on measurement reveals that this concept has been blighted by a lack of a precise definition. For example, Campbell (1952) argues that for measurement to occur the measurement structure should be defined in such a way that it satisfies the axioms of additivity. This definition reflects that the properties of all measurable phenomena should be capable of representation by positive natural numbers. Luce *et al.* (1971) point out that all additive measurements are extensive measurements. It can be inferred from this that Campbell (1952) believes that all measurements must be extensive measurements. Stevens (1959:24) asserts that in order for some form of measurement to take place, all that is required is a consistent rule of assignment. It is clear from this that the random assignment of numbers to objects is excluded. It is also clear that measurement does not have to be additive. This also indicates that Stevens' (1959) view of measurement is broader than that of Campbell (1952). That is to say, since both additive and non-additive measurements are included in Stevens' (1959) point of view of measurement, his view includes more forms of measurement than that of Campbell (1952).

In the early definition of measurement given above by Campbell (1952), it is evident that the concept of the additivity of measurements was seen as fundamental to the definition of measurement. This requirement excluded measurements in the social sciences. Luce *et al.* (1971:123) point out that the lack of an adequate interpretation for the concatenation operation makes it difficult in most attempts to apply the theory of extensive measurement to non-physical attributes such as utility, intelligence or loudness. In particular, it is difficult to find an adequate interpretation for an additive operation in the social sciences. Accounting is a social science and consequently it lacks an adequate

interpretation of the concatenation operation that is found in the natural sciences. This has led to the development of other axiom systems as a basis for fundamental measurement in social science, such as difference measurement, conjoint measurement and expected utility measurement (Luce *et al.*, 1971:124). These axiom systems are not additive structures. This indicates that the requirement that all measurements should have a concatenation operation is not sufficient to cover all the aspects of the concept of measurement.

A move towards a more modern definition of measurement was made by Caws (1959:5). He defines measurement as “the assignment of particular mathematical characteristics to conceptual entities in such a way as to permit an unambiguous mathematical description of every situation involving the entity and the arrangement of all occurrences of it in a quasi-serial order”. This definition implies that there should be a precise knowledge of the relationship between the assigned numbers and the underlying empirical relational structure. It is not possible to measure a phenomenon of which one has no knowledge. Willet (1987) points out that in the accounting discipline the relationship between value and the monetary units assigned to represent it is not known. This suggests that value is currently not measurable in accounting. Caws (1959:3) adds, “measurement presupposes something to be measured, and, unless we know what that something is, no measurement can have any significance”. This reinforces the fact that a precise description of the qualitative structure is required before measurement takes place.

The modern definition of measurement appears to require that measurements be representative of the underlying phenomenon. Orbach (1978) points out that although the precise definition of measurement requires a mathematical formulation, measurement may be described as the process of identifying selected attributes of a set of objects (or events) and assigning numbers (or mathematical entities, such as vectors) to objects so that the properties of the attributes are “preserved” or “represented” by the assignment. In defining measurement this way, he points out that all measurements are representative of

the underlying phenomenon and are also unique. Similarly, Narens (2002:746) states, “ ... each meaningful set of measuring functions on a qualitative domain **A** has a characterization as a set of structure preserving mappings from a qualitative structure with domain **A** into a purely mathematical structure”.

This quotation points out that measurement only occurs if there is a representation of the empirical relational structure with a numerical relational structure in such a way that the properties of the empirical relational structure are preserved by the numerical relational structure. This concept of the representational theory of measurement reinforces the belief that all measurements must be representative of the properties of the structure they purport to be representing. This indicates that it should be possible to infer an empirical relational structure from the numerical relational structure that is representing it. Mundy (1986) also emphasises that all measurements should be representative of the properties of the phenomena they purport to be representing. It follows, then, that all that is necessary for measurement to occur is a true representation of the properties of an empirical phenomenon by a numerical relational structure. This is the theory of measurement that is discussed in this study.

The discussion above indicates that the lack of a precise definition has led to a poor understanding of the concept of measurement over the years. It can be argued that this poor understanding of the concept has been demonstrated in the accounting discipline (e.g. Chambers, 1997; Gilman, 1939; Ijiri, 1975, 1967; Littleton, 1953; Paton and Littleton, 1940; Staubus, 2004, 1985; Sterling, 1966) by the lack of success of accounting researchers over the years in establishing a theory of accounting measurement. Furthermore, it is currently still not known what the monetary units in financial statements represent (Ryan *et al.*, 2002:118). This means that the empirical relational structure that monetary units represent in accounting is unknown. This has created a representation problem in the concept of measurement in accounting.

### 2.3.1 Sources of the principles of the representational theory of measurement

This section identifies the main sources of the principles of the representational theory of measurement that are used in this study. The literature review in this study has led the researcher to come to the conclusion that although there is a great deal of literature on the representational theory of measurement, currently there are no other comprehensive sources on the principles of representational measurement other than the three volumes of measurement entitled *The Foundations of Measurement* by Luce *et al.* (1971, 1989, 1990). Although other sources of the principles of representational measurement, such as Stevens (1951), Luce and Narens (1994), Michell (1995), Decoene *et al.* (1995) and Narens (2002) will be consulted extensively in this study, the main sources will be the three volumes mentioned above.

In volume one of the *The Foundations of Measurement* (Luce *et al.*, 1971) consideration was given to structures having a natural concatenation operation, representable by a sum or by a weighted average, and structures in the combined effect of several factors on some one-dimensional, ordered attribute that is representable by an additive or a polynomial combination rule. In other words, volume 1 discusses measurement in only one dimension. In the present study, consideration is likewise given to measurement in one dimension. That is to say, consideration is given only to those attributes that do not involve multiple representations. Consequently, the principles of representational measurement discussed in volume 1 are relevant to this study.

Volume 2 (Luce *et al.*, 1989) of *The Foundations of Measurement* deals with multidimensional measurement. This volume discusses the principles of measurement that are used to measure an attribute that has many dimensions. According to Luce *et al.* (1989), common examples of multidimensional measurement occur in geometric representations. However, because of the large volume of principles of multidimensional measurement, these principles will not be



discussed in this study. They are, however, given as a recommendation for further study in chapter 14.

Volume 3 of *The Foundations of Measurement* (Luce *et al.*, 1990) deals with the concept of meaningfulness in measurement. It discusses the invariance of measurements under sets of circumstances. Attention is given to the concept of meaningfulness in the present study. The principles of meaningfulness outlined in this volume are applied to the accounting concept of measurement to evaluate whether or not current accounting measurements are meaningful.

It is also recommended by Luce *et al.* (1971) that for a scholar to understand the principles of representational measurement, he or she must be familiar with the elementary, and in some cases, where mathematical proofs are required, advanced mathematical material on sets, relations, functions, probability, abstract algebra, topology and calculus. The author did consult these materials for the purposes of this study. The reader too will need to be familiar with these mathematical materials in order to fully understand the principles of the representational theory that are outlined in the sections that follow.

## **2.4 The historical background of the representational theory of measurement**

The developments in the theory of measurement can be traced back to the Greeks. But Helmholtz (1887) makes one of the earliest attempts to state explicitly, in terms of an ordered system with empirical operations, the collection of empirical laws that give rise to an additive numerical representation. A number of mathematicians and scientists, among them Holder (1901) and von Neumann (in von Neumann and Morgenstern, 1947), also clearly had the idea of axiomatizing ordered qualitative structures as possible models of empirical attributes and, in the latter two cases, of establishing, as mathematical theorems, the existence and uniqueness of numerical representations.

However, this approach was considered too general, and was not widely accepted by empirical scientists or philosophers of science during the first half of the 20<sup>th</sup>

century. This is evidenced by the discussions of measurement in, for example, Bridgman (1922, 1931), Campbell (1920, 1928), Cohen and Nagel (1934), and Ellis (1966). In a resurgence of interest in the middle part of the 20<sup>th</sup> century, which has extended to the present, this axiomatic style of studying the measurement of attributes was brought to the attention of non-mathematicians. Various improvements and generalizations of extensive measurement structures were developed. The most important pioneering works were the works of Suppes (1951), Scott and Suppes (1958) and Suppes and Zinnes (1963). The concept of measurement emphasized by these works focused on the representation and uniqueness theorems.

Under these two theorems, new ordered mathematical structures that appeared to have relevance to the measurement of certain attributes were isolated, and two theorems were established: the existence of a representation into or onto some prescribed numerical structure, and the uniqueness of that representation in the sense of formulating the class of transformations relating equally good representations into or onto the same numerical structure. This is the concept that has come to be known as the representational theory of measurement.

## **2.4.1 The underlying principles of representational measurement**

### **2.4.1.1 Background to the representational theory of measurement**

Before the development of the representational theory, the concept of measurement was based on the realist's perspective of measurement. According to the realist's theory, measurement is the discovery of numerical relations between magnitudes of some quantity and a unit magnitude (Michell, 1995:245). This suggests that the numerical relations discovered in measurement are taken to be logically independent of the measurers and their activities. This also means that the numbers assigned under the realist's perspective are intrinsic to circumstances. They are the empirical relations that are referred to in a

measurement situation. However, this view of measurement was particularly difficult to apply in the social sciences where numbers are sometimes external to the situations they are applied to. In other words, researchers in the social sciences were not able to verify whether the properties of the phenomena they were studying were identical to the properties of the numbers they assigned to them. A result of this was the development of the representational theory of measurement.

The representational theory of measurement (Luce *et al.*, 1971; Luce, *et al.*, 1990; Luce, *et al.*, 1989) is the most popular form of measurement theory in the social sciences. This theory is also known as the modern measurement theory. Its applications are particularly notable with respect to the development of methodology and theory construction in psychology (e.g., Coombs, 1983; Falmagne, 1992; Luce, 1992; Marley, 1991, 1992; Narens and Luce, 1993; Roberts, 1979). Consequently, these applications of this theory of measurement in the social sciences, particularly in psychology, have made it an indispensable part of the social sciences.

According to Narens (1985:5), representational measurement consists in specifying homomorphisms of some qualitative (or empirical) structure into a numerical one. This definition of representational measurement highlights that, for measurement to occur, there must be a specified qualitative structure, a homomorphism and a numerical relation structure. A homomorphism is a mapping between two algebraic structures in such a way that the result obtained by applying the operations to the elements of the first set is mapped onto the result obtained by applying the corresponding operations to their respective images in the second (Bhattacharya, Jain and Nagpaul, 1986:70). A homomorphism is thus a function that explains the transformation of an algebraic structure onto another algebraic structure. It is also evident that, in the absence of a homomorphism, it would not be possible to trace the path taken by an algebraic structure during its transformation into another algebraic structure. Consequently, in measurement it is necessary to know the type of algebraic structure that is used to represent the

property of an object during the process of measurement in order for this measurement to make sense. For example, it is important to know whether the height of an object is in centimetres or in metres.

Scott and Suppes (1958) assert that a primary aim of measurement is to provide a means of convenient computation. This viewpoint highlights the fact that the choice of a numerical structure to represent a specific empirical structure is strongly affected by considerations of computational convenience. It follows that the choice of homomorphism is also based on computational convenience. Adams (1966) points out that the representational theory of measurement is built on the basis that mathematical operations and relations are made to correspond to or represent empirical relations. This means that measurement occurs as soon as the empirical relational structure is represented by an abstract structure. Basically, the concept of representational measurement can be described as an attempt to understand the nature of empirical observations that can be usefully recorded, in some unique fashion, in terms of familiar mathematical structures (Luce and Suppes, 2001). Before any measurement can take place, therefore, it is necessary to fully understand the phenomenon that is being measured. It is thus clear that if accounting is to be considered a measurement discipline then accounting phenomena must be fully understood before measurement can take place.

#### **2.4.1.2 The formal principles of the representational theory of measurement**

This section includes some elementary definitions and concepts of measurement which are useful to reading the remainder of this study. However, the material in this section is not meant to be a formal or complete discussion of measurement theory. For such a complete discussion, the reader is invited to consult Luce, Krantz, Suppes and Tversky (1971, 1989, 1990).

It is important to note that for a measurement to be regarded as a representational measurement, it has to adhere to the principles of the representational theory of

measurement. Luce and Narens (1994) summarised the formal part of the principles of the representational theory of measurement and have reduced them to five main ideas that have been italicised below as follows:

1. *“A qualitative situation is specified by a (usually ordered) relational structure  $X$  consisting of a domain  $X$ , of infinitely many relations of  $X$  and infinitely many special elements of  $X$ .*

*These relations, subsets, and elements are called the attributes of  $X$ . Measurement axioms are then stated in terms of the attributes of  $X$ . These axioms are intended to be true statements about  $X$  for some empirical identification and are intended to capture important empirical properties of  $X$ , usually ones that prove useful in constructing measurements of its domain,  $X$ .”*

This extract highlights the point that precise knowledge of the object of measurement is necessary before any measurement can take place. In this case it is necessary to have adequate knowledge of a relational structure before any measurement can take place. According to Orbach (1978), a relational system consists of a set, and a set of relations defined on the set. This means that all the elements in the set are bound by the properties that are common to the members of the set. Furthermore, the extent to which every member of the set possesses a particular property is known with certainty.

The excerpt above also points out that true statements (axioms), that describe the empirical properties of the empirical relational structure, usually those that are useful in constructing measurements of the elements of the empirical relational structure, should be stated. This means that it is necessary to clearly state the property or the attribute that is of use and interest to measure before any process of measurement can commence. Luce *et al.* (1971) also point out that a set of axioms that is useful in the measurement of the attributes of an empirical relational structure must be treated as a set of qualitative laws. If this is the case,

it means that the attributes and relations of an empirical relational structure that are of use and interest to measure must be objective and empirically testable.

The explanation above further points out that the qualitative situation is specified by a usually ordered relational structure: the concept of order is preserved under monotonic transformations. A monotonic function is one that preserves a given order (Zimmermann, 1981). This suggests that the functions that transform the empirical relational structure onto the numerical relational structure must be order preserving. Stevens (1951) asserts also that the relations defining order must have three attributes: they must be connected, asymmetrical and transitive. These attributes are briefly discussed below:

- They must be connected- A relation is connected when, given any two terms of its field, the relation holds between the first and the second or between the second and the first (Russell, 1920:33). This means that given any two elements in a set, a relation that is defined on the set must hold between the two given elements (see chapter 4).
- Asymmetrical- An asymmetrical relation is a relation that holds in one direction only. That is, the order of the relationship is unidirectional (see chapter 4).
- Transitive- A transitive relation is a relation that holds on more than two elements of a set without these elements having to be directly related. In a transitive relation there can be a relationship between the first and the second element of a set, and a relationship between the second and a third element that automatically implies a relationship between the first and the third element. For example, if **a** is related to **b**, and **b** is related to **c**, then **a** is related to **c** if the relationship is transitive (see chapter 4).

The existence of these attributes must be tested in order to confirm the existence of order. It can therefore be inferred from this discussion that if accounting is to be considered a measurement discipline, it is essential to specify accounting qualitative structures using relational structures that have specified domains,

elements and specified relations among the elements of the domain. Statements about the measurement of the attributes of accounting phenomena will then have to be made in terms of the elements and relations of the domain of the accounting qualitative structure. In section 2.3 it was noted that in every process of measurement it is necessary to know with certainty the object that is being measured. It was also argued that accurate knowledge of what is being measured gives measurement significance. This means that it should be possible to know what a measurement stands for. Therefore, the specification of the qualitative structure of an accounting phenomenon ensures that accounting measurements are significant.

The excerpt also notes that every measurement process should find a good axiom system. In addition, the extract asserts that the choice of the qualitative axioms is of fundamental importance in deciding whether the representational theory of measurement can be applied to a situation. According to Luce *et al.* (1971), a measurement system is not adequately understood if it depends on properties that are not explicitly recognized. Once they are explicit, deciding whether or not the same measurement procedure is applicable in a new domain is reduced to testing whether or not the requisite properties are satisfied. It also follows that the establishment of a good axiom system is necessary in deciding whether a theory of measurement is applicable to a situation or not.

*2. "The representational theory requires that the primitives of X be given an empirical identification.*

*In particular, if R is an n-ary primitive relation on X, then it is required that the truth or falsity of R (xi...xn), for any particular choice of the n-tuples xi, be empirically decidable."*

This excerpt indicates that each identified primitive of the empirical relational structure should be given an identification that can be tested empirically. Furthermore, it can also be inferred from this excerpt that each property of a class of objects that is of use and interest to measure must be unique and able to be empirically identified. This emphasizes the empirical nature of measurement. It

follows that there is no way of having a measurement process that is not empirical, given that the attributes that are being measured must be empirical. Luce *et al.* (1971) point out that the measurement axioms constructed from the primitives are regarded as a set of empirical laws. This implies that the primitives of the empirical relational structure from which the measurement axioms are constructed should also be regarded as a set of empirical laws. It can be further inferred that different properties of a class of objects cannot share the same empirical identity. Each property of a class of objects that is measurable must have a unique identity.

In chapter 1 it was noted (IASB, 2006; Wolk *et al.*, 2001) that accounting measurement focuses on the measurement of value. This means that it would be expected that value should be compatible with the principles of representational measurement. Since the extract above points out that the attribute that is the subject of measurement should have an empirical identity, then it follows that value should also have an empirical identity. An empirical identity of value is useful in the identification of value. With a specified empirical identity of value it is possible to test whether a particular measurement is indeed a measurement of value.

**3. *“As much as possible, measurement axioms, stated in terms of the empirically identified primitives, should be empirically testable”***

This extract underlines that all the measurement axioms describing the measurement of the specified attributes of an empirical relational structure, should be empirically testable. This implies that the measurements that are constructed from empirically testable axioms must also be empirically testable. This reflects the objective nature of all measurements. It follows that if the empirical relational structure is objective, then measurements of the empirical relational structure must also be objective.

It should also be noted that the empirical testability of a measurement axiom is a matter of convention. Luce *et al.* (1990) point out that the idea of empirically



testing axioms is more closely associated with problems of statistical inference than with problems of axiomatizability. They also argue that the total set of structures admitting homomorphism into a particular numerical structure is very heterogeneous and may include instances that are difficult to describe. If this is the case, measurement axioms are an abstraction and they are subject to arbitrary conventions. It follows that their empirical testability is dependent on these conventions. It can further be inferred that the meaning of measurement axioms is dependent on conventions.

The IASB framework (2006, Para 83) for financial reporting, identifies cost and value as the attributes that are subject to measurement. This means that measurement statements in accounting are made only about cost or value, as they are the only identified attributes in accounting. The extract points out that, measurement axioms, stated in terms of the empirically identified primitives, should be empirically testable. If this is the case, it follows that measurement statements in accounting made about cost or value should be empirically testable.

4. *“Measurement of S is said to take place if and only if the following two theorems can be shown:*

- i. *(Existence Theorem). S (x) is non-empty for each X that satisfies the measurement axioms.*
- ii. *(Uniqueness Theorem). An explicit description is provided about how the elements of S (x) relate to one another. In practice this description usually consists of specifying a group of functions G for each 4 in S (x). S (x) = {g\*4:g is in G}, where \* denotes function composition.”*

This excerpt claims that the existence theorem and the uniqueness theorem are the most important principles of the representational theory of measurement. Luce *et al.* (1971) assert that the uniqueness and existence theorems are satisfied by the formulation of a set of sufficient axioms, which assert the existence of a homomorphism into a particular numerical relational structure and which specify the permissible transformations that also yield homomorphisms into the same

numerical relational structure. It is clear, then, that the existence theorem is satisfied if it can be shown that scaled values correspond to empirical phenomena. Hence, it can be concluded that the existence theorem is satisfied by testing whether the set of all elements that define the domain of the empirical relational structure is not an empty set.

The IASB framework (2006, Para 83) for financial reporting points out that an item that meets the definition of an element of financial statements should be recognized if it has a cost or value that can be measured with reliability. This viewpoint identifies cost and value as the attributes that are the subject of measurement in accounting. The extract points out that the existence theorem focuses on testing whether the set of all elements that define the domain of an empirical relational structure is not an empty set. Thus, it can be inferred that the existence theorem in accounting should focus on proving whether cost or value truly exist for a given set of accounting phenomena.

The extract also asserts that the uniqueness theorem is proved by the specification of the type of transformations under which a scale is invariant. Churchman and Ratoosh (1959) also note that a number assigned to measure a property is unique once a unit of measurement has been chosen. Consequently, it can be concluded that the specification of the unit of measurement satisfies the uniqueness theorem. The specification of a unit of measurement clearly specifies the relationship between a measure and the attribute that is being measured. The unit of measurement also specifies how the elements of a particular set relate to one another with respect to that particular attribute.

According to Abdel-Magid (1979), monetary units are a measure of value in the accounting discipline. Since the extract points out that a number assigned to measure a property is unique once a unit of measurement has been chosen, this means that monetary units assigned to measure value are only unique once the unit of money is specified (e.g., Rand, Dollar, etc.).

5. *“The representational theory of measurement identifies empirical significance with meaningfulness.*

*The concept of meaningfulness with respect to  $S(X)$  is easily extended to numerical statements involving measurements of elements of the domain: meaningful statements are those whose truth-value is unaffected by the particular representation in  $S(x)$  used to measure  $X$ .”*

It is clear from this extract that representational measurement takes place if the measurements are meaningful. It is also clear that representational measurement regards meaningful statements as empirically significant statements. Churchman and Ratoosh (1959) point out that an empirical hypothesis, or any statement of fact which uses numerical quantities, is empirically meaningful only if its truth-value is invariant under the appropriate transformations of the numerical quantities involved. This means that a measurement is meaningful if it is clear what statements may be made about the measure that preserve its true meaning. It can also be inferred that a measure is meaningful if it reflects the true properties of the empirical relational structure.

The concept of meaningfulness originates from Stevens' (1946, 1951) typology of scales. In Stevens' (1946, 1951) typology the meaningfulness problem refers to the determination of the truth or falsity of statements based on comparisons of assigned scale values. This is done by determining the type of statistical procedures that may be carried out on the data structure without changing the scale of measurement on the data structure. Therefore, one can see that a theory of meaningfulness consists of giving necessary or sufficient conditions for meaningfulness. It follows that the essence of meaningfulness is embodied in the description of scale types and permissible statistics.

According to the IASB framework (2006, Para 99) for financial reporting accounting “measurement is the process of determining the monetary amounts at which the elements of the financial statements are to be recognized and carried in the balance sheet and income statement”. This means that monetary amounts are

used to represent the attributes of the elements of the financial statements. Monetary units are thus a measure of the attributes of the financial statements. It has been noted from the extract above that meaningfulness is concerned with the identification of the statistical procedures that may be carried out in a measure without changing the scale of measurement on the data structure. Therefore, this means that in the accounting discipline the concept of meaningfulness is concerned with the identification of the statistical procedures that may be carried out on the monetary amounts without changing the scale used in representing the attributes of the elements of the financial statements with monetary units.

## **2.5 The application of the representational theory of measurement**

From the analysis of the representational theory of measurement above in section 2.4, it is clear that the choice of the qualitative axioms is of fundamental importance in deciding whether the representational theory can be applied to a situation. It should be pointed out that the choice of the qualitative axiom system depends on the individual performing the analysis. Scott and Suppes (1958) make it clear that the primary aim of representational measurement is to provide a means of convenient computation. The word “convenient” in this context implies a form of measurement that is handy to the user. Therefore, this makes the choice of the measurement method highly subjective and dependent on the user.

The representational theory of measurement only focuses on those relations that the experimenter wishes to represent with an abstract structure. For example, Decoene *et al.* (1995) claim that the qualitative axioms of an empirical situation are an abstraction and the empirical domain is rarely understood to such a degree that the chosen axioms will fit the regularities of the empirical domain perfectly. They argue that the ideal situation with respect to the qualitative axioms would be that only those axioms that have a direct and testable empirical content are chosen. This suggests that representational measurement only focuses on those attributes that one wishes to measure and not on everything else surrounding it. In chapter 1 it was noted that the objects of measurement are cost and value. It can

be inferred that it is not necessary to fully understand cost and value, but only those aspects of cost and value that are essential in their measurement. Therefore, it follows that accountants should focus on those relations of cost or value that they wish to measure.

One of the most important concepts introduced to measurement theory by the representational theory of measurement is the concept of axiomatization. Cliff's (1992) view is that the representational theory of measurement can best be understood as implying a new scientific thinking in which the advantages of axiomatization are of paramount importance. The purpose of the representational theory of measurement is to study the existence conditions of measurement structures and not the description and explanation of how actual measurement procedures arise in science as it is practised now (Decoene *et al.*, 1995). It investigates whether the properties and relations that are said to be on an empirical relational structure actually exist. All the assumptions made about a phenomenon in representational measurement must be shown to be true. Therefore, if cost and value are the objects of measurement, it can be inferred that all the assumptions about cost or value made by accountants must be shown to be true. Luce and Narens (1994) also make the point that the attributes of a phenomenon must be empirically decidable and the axioms that describe the measurement of these attributes must be empirically testable. It can therefore be concluded that all representational measurements must be objective. Consequently, it follows that measurements of cost and value in accounting must also be objective.

For Mitchell (1995), the view is that the representational theory of measurement equates measurement with numerical coding (albeit a complex variety where relations are numerically coded along with attributes). He argues that numerical coding always involves a conventional component: the agreement to code certain empirical attributes with certain numbers, and certain empirical relations with certain numerical ones. It is this component that is captured by the representation's uniqueness theorem. This suggests that every pair of the

representation and uniqueness theorems involves an arbitrary choice of a numerical relational structure. Stevens (1951) considers the concept of measurement as more immediately the goal of the experimental corner where the patient sifting of facts and relations has disentangled some of the relevant variables. The experimenter must have a good understanding of the phenomenon before measurement can take place. The choice of an appropriate qualitative axiom system depends entirely on a deep understanding of that part of reality one is studying. As a result, the choice of method of assigning numbers to the relations one has discovered entirely depends on oneself. It follows that in the accounting discipline the choice of the measurable attributes of cost or value is entirely dependent on the accountant who is performing the process of measurement. This accountant must thus have a good understanding of the concept of cost or value before measurement of these attributes can take place. Decoene *et al.* (1995) contend that when a domain is poorly understood, it is impossible to arrive at an explanation that suggests appropriate qualitative axioms. They also argue that there is no way of posing the question of measurement of a variable prior to an understanding of the structure of a variable. It is clear that the task of understanding the empirical domain of the variable belongs to the scientist. It follows that the representational theory of measurement is basically about proving representation and uniqueness theorems for the mapping of a given empirical relational structure into a formal relational structure, chosen by convention.

According to IASB (2006, Para 99), accounting measurement is the process of determining the monetary amounts at which the elements of financial statements are to be recognized and carried in the balance sheet and income statement. Since it has been noted (IASB, 2006) that the objects of measurement in accounting are cost and value, it can be inferred that measurement in accounting is the assignment of monetary units to represent the cost or the value of the elements of the financial statements. Therefore, in the accounting discipline, before a claim can be made that a particular measurement of the attributes of cost or value has been made, it is necessary to prove the representation and

uniqueness theorems for each mapping of the empirical relational structure of cost or value onto the monetary units.

## **2.6 Weaknesses of the representational theory of measurement**

This section discusses the weaknesses of the representational theory of measurement. The shortcomings of representational measurement should not be perceived as the shortcomings of accounting. They are the shortcomings of representational measurement as a tool of measurement in the social sciences and not the shortcomings of accounting as a discipline.

One of the chief criticisms of the representational theory of measurement is its inability to deal sufficiently with the problem of error. A quantitative treatment of errors is impossible with the representational theory of measurement (Decoene *et al.*, 1995). This problem is related to the testability of qualitative axioms. The construction of numerical scales of measurement is subject to arbitrary conventions. The problem of error refers to the context, which involves difficult conceptual problems concerning the relation between detailed, inconsistent data and the abstraction derived from them, and the empirical relational structure (Luce *et al.*, 1971:13). It is clear from this that sometimes the experimenter might fail to observe exactly what he wishes to observe in the social sciences, because it is sometimes difficult to relate the observed phenomena to the observations made by the experimenter. It also suggests that social scientific phenomena are dependent on the opinion of the observer and, as a result, it is difficult to deduce whether the opinion of the observer is true or inaccurate. Hence, it is difficult to set a standard against which observations can be compared. It is thus not possible to establish the amount of error in an observation.

According to Decoene *et al.* (1995), in order to evaluate whether a given qualitative axiom is satisfied, the scientist needs data, and data inconsistencies with respect to a given qualitative axiom place a forced choice before the scientist. They argue that the scientist has to conclude that either the qualitative axiom is

not satisfied or the data are bad. It is evident from this that if the data given do not satisfy the axioms being tested it is difficult for the scientist to tell whether the axioms they are investigating do not exist in that data or whether the data they have is not representative of the phenomena they are studying. This problem is not dealt with by the representational theory of measurement when it is applied to the social sciences.

The second criticism of the representational theory is based on the idea that measurement is ontologically committed to the existence of quantities, independent of their measurement (Decoene *et al.*, 1995). They argue that since the representational theory of measurement is based on the idea that the purpose of measurement is to provide a means for convenient computation, then the representational theory of measurement is too liberal in what it considers to be measurements. It is clear from this that the representational theory of measurement does not limit measurements to only those that reflect the intrinsic properties of the object they are measuring, but also includes numerical assignments that do not reflect the intrinsic properties of the object being measured. Michell (1995) points out that the realist theory of measurement entails that Stevens' (1946) categories of nominal and ordinal scaling are not measurement. His argument is that these scales do not involve ratios between magnitudes of a quantity. This means that proving that numbers are existing entities proves the representational theory of measurement wrong. However, Mitchell (1995) also argues that if the underlying principle of measurement is numerical representation then there is no reason to exclude nominal scales. As a result, this study also views nominal scales as genuine scales of measurement.

## **2.7 Summary and Conclusions**

It seems plausible to conclude from this chapter that the reason measurement theory has received so little attention from accountants may be explained in part by the fact that until recently a comprehensive theory of measurement for the social sciences was lacking. Luce *et al.* (1971, 1989, 1990) in their three volumes



of The *Foundations of Measurement* provide a comprehensive guide to modern measurement theory. This is the theory of measurement that is referred to in this study as the representational theory of measurement.

Although the representational theory began largely as a way of understanding the source of physical measurement it has provided useful applications to the behavioural and social sciences. As outlined earlier, the applications of the representational theory of measurement are particularly notable in the development of methodology and theory construction in psychology. Since both psychology and accounting are social sciences, it is reasonable to suggest that the representational theory of measurement can also form part of accounting methodology.

The principles of the representational theory of measurement validate whether a particular numerical assignment in social sciences can be described as a measurement. This indicates that the representational theory of measurement creates a norm for measurements in the social sciences to follow. The application of the representational theory of measurement to accounting practices to determine whether or not they reflect the properties of a true measurement system can thus be regarded as normative research.

The trends in accounting measurement research indicate that the perspectives of the accounting concept of measurement have not changed over the past sixty years. Views of the concept of measurement held by accountants sixty years ago have not changed much today. This indicates that no progress has been made in developing accounting measurement principles.

It is also clear from this chapter that it is necessary to specify the preformed theoretical constructs of the empirical relational system, the measurement function and the value of the measurement function. The specification of these ensures that the precise specification of the object of measurement, the numerical relational system onto which the object is mapped, and the scale of measurement is made before measurement can take place.

The main criticism of the representational theory of measurement is its inability to deal adequately with the concept of error. This problem is related to the testability of qualitative axioms. The construction of numerical scales of measurement is subject to arbitrary conventions. The problem of error refers to the context, which involves difficult conceptual problems concerning the relation between detailed, inconsistent data and the abstraction derived from them, the empirical relational structure. Sometimes an experimenter might fail to observe exactly what he intends to observe. As a result, measurements should always leave room for such errors of observation.