Planning Assurance Services for Sustainability Reporting

Rajendra P. Srivastava
Ernst & Young Distinguished Professor and Director
Ernst & Young Center for Auditing Research and Advanced Technology
School of Business, The University of Kansas
Lawrence, Kansas 66045
Phone: (785) 864-7590, Fax: (785) 864-5328
e-mail: rsrivastava@ku.edu

Sunita S. Rao
Ph.D. Student
School of Business, The University of Kansas
Lawrence, Kansas 66045
e-mail: ssrao@ku.edu

Theodore J. Mock
Distinguished Professor of Audit & Assurance
Anderson Graduate School of Management
University of California, Riverside
Professor of Audit Research
University Maastricht
Email: tmock@ucr.edu

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ABSTRACT

This study investigates providing assurance on sustainability reporting and demonstrates how an evidential reasoning approach can enhance providing such a service. It develops a framework based on the Dempster-Shafer theory of belief functions for the purpose of audit program planning and cost analysis, both critical to providing efficient and effective assurance services. This framework allows the assurance provider to control audit risk and plan the service at a minimum cost by focusing on those audit procedures that provide the desired assurance for each assertion of interest.

A sensitivity analysis is used to demonstrate the value of the model based on five scenarios. The cost to perform an audit procedure is assumed to increase exponentially with the increase in the targeted level of assurance and audit procedures are assumed to exhibit inherent limitations as to the maximum level of assurance they can be expected to provide.

Results demonstrate;

i. the value of the assurance provider developing the most reliable (most diagnostic) procedures that directly relate to the highest level assertions,
ii. the effects of discovering during the audit that certain audit tests are less diagnostic than anticipated,
iii. the effects of obtaining mixed audit evidence and lastly
iv. the effects of obtaining strong evidence that implies that certain assertions are not fairly stated.

Each of these findings demonstrates the potential value to practice of utilizing a formal evidential reasoning and cost minimization approach in providing assurance on sustainability reports.

Key Words: Assurance Services, Sustainability Reporting, Assurance Planning, Cost Analysis, Dempster-Shafer Theory, Belief Functions

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1. INTRODUCTION

The objective of this paper is to demonstrate the use of an evidential reasoning approach under the Dempster-Shafer theory of belief functions (hereafter referred to as DS theory, Shafer 1976) to assist in planning assurance services for sustainability reporting. To demonstrate the application of this framework we apply it to several realistic scenarios and perform sensitivity analysis.

Research on sustainability is important because an increasing number of entities are striving to measure, report and reduce their environmental and social impact (Labuschagne, Brent and van Erck 2005; Vanclay 2002; Brudge 2002). We focus on sustainability reporting and its assurance because a growing number of companies are issuing sustainability reports and a substantial number of companies are also getting these reports assured (Wallage 2000, Mock et al. 2007, Mock et al. 2010). Research related to assurance on sustainability reporting may:

- Add value in terms of improving future corporate performance, transparency, and accountability.
- Lead to better ways of providing assurance and reporting.
- Enable companies to find out if market participants value sustainability information and assurance on it. In particular, if research reveals that market participants use sustainability information and assurance to facilitate investment decisions, companies may enhance reporting content and perhaps report more frequently.
- Facilitate investors, regulators and other stakeholders in determining the accuracy of the information and evaluating the degree to which other market participants view assurance as raising the value of the reported information.

Sustainability reporting (SR) which is also known as corporate sustainability reporting (CSR), corporate social responsibility (CSR) reporting, and triple bottom line (TBL) reporting,

provides data on financial and non-financial factors related to environmental, social and governance issues that affect future performance, income generation and value preservation. The February 2007 issue of *Business Finance* emphasized that sustainability reporting is a crucial companion to financial reporting and reported that two-thirds of the 250 largest companies in the world have adopted sustainability reporting as a tool to gauge future performance.

Currently most companies providing Corporate Sustainability Reports (CSR) follow the guidelines developed by Global Reporting Initiative (GRI), a non-profit organization based in Amsterdam. GRI issued its 3rd generation G3 Reporting framework in October 2006 after a three-year innovative development period that engaged more than three thousand individuals from a diverse set of backgrounds. The G3 Reporting framework consists of reporting principles, reporting guidance, and standard disclosures including performance indicators.

There are three important issues the assurance provider needs to consider in judging whether a CSR has been prepared in accordance with G3 or other guidelines. The first issue deals with the principles and criteria that need to be adhered to by the reporting company in preparing the CSR. The second issue deals with the evidence gathered by the assurance provider related to various principles or criteria to make judgments about whether these principles and criteria have been met. The third issue deals with representing and managing uncertainties and risks involved in the evidence gathered to make an overall judgment whether the principles and criteria have been met.

In many jurisdictions, there are no professional bodies such as the PCAOB or AICPA, which regulate the provision of assurance services for sustainability reporting. Thus, assurance providers may use a variety of standards including the international standards promulgated by the IAASB (2005) or local standards such as the Dutch standards (DASB 2009). Some assurance

providers have used ad-hoc approaches (Mock et al. 2007,2010).

As described earlier, the first objective in this paper is to demonstrate the use of an evidential reasoning approach as a structured approach for providing assurance on CSR. To deal with the first issue identified earlier, we use GRI's G3 guidelines for reporting principles and criteria. To determine the relevant items of evidence pertaining to specific principles and criteria, we again refer to G3 guidelines. To deal with the third issue, we use DS theory to represent the uncertainties and risks associated with the provision of CSR assurance.

Under an evidential reasoning approach, one develops an evidential diagram consisting of variables the assurance provided needs to consider, interrelationships among the variables, and items of evidence pertaining to these variables. The variables that need to be considered consist primarily of the assertions that assurance is provided on and the evidence that is collected and evaluated. The evidential network development is elaborated in Section 3.

As mentioned earlier, we use DS theory to represent uncertainties involved in the evidence gathered in the process of providing assurance on sustainability reporting because it provides an appropriate framework for mapping uncertainties in the audit evidence (Shafer and Srivastava1990; Srivastava and Mock 2005). Moreover, there is empirical evidence in psychology (Curley and Golden 1994) and in auditing (Harrison et al 2002; Fukukawa and Mock 2011) that show the advantages of using DS theory in uncertain decision-making settings.

This article contributes to assurance literature in three significant ways. Most notably, it is the first research that looks at sustainability reporting assurance using a formal evidential reasoning approach. Second, it is one of the first studies in the audit and assurance literature that introduces the concepts and methods for making decisions using a cost analysis approach under DS theory (see also, Srivastava and Mock. 1999-2000). This study adds to this literature by

introducing an audit program planning and cost analysis approach to determine the audit procedures which are expected to provide the needed level of assurance at the minimum cost. Since the cost in providing an assurance service depends on the cost associated with obtaining evidence to verify different principles and criteria, it makes economic sense to minimize audit procedure cost given the desired level of assurance. This approach is different from prior approaches (e.g., see Srivastava and Shafer 1992, Srivastava and Mock 1999-2000 and Sun et al 2006) where audit evidence or assurances are combined without explicit consideration of the expected cost associated with each audit assertion or sub-assertion.

Finally, this is the first study to demonstrate analytically the importance of items of evidence at a higher level of assertion in the evidential diagram. This finding is consistent with and supports what is being done in practice (KPMG 1977). In addition, our model depicts audit planning in a real world setting, where the cost to perform an audit procedure is assumed to increase exponentially with an increase in the targeted level of assurance.

The remaining part of the paper is divided into six sections. The following section provides the background research in the field of sustainability reporting assurance services. The next section describes the evidential reasoning approach and the use of evidential diagrams to illustrate the aggregation of evidence. In Section 4, a hypothetical case is presented that demonstrates how an assurance provider can use an evidential reasoning approach to perform a sustainability reporting assurance service. Section 5 discusses the assurance planning process and cost analysis and develops five scenarios to investigate the effects on assurance costs of various types of audit situations. The final section summarizes the conclusions and limitations of the study.

2. BACKGROUND RESEARCH

Sustainability reporting is *a structured way an entity reports on its economic, environmental, and social performance* which gives companies a means to report how non-financial factors affect the financial figures and how these factors can ultimately help to drive the company's value (Mock et al 2007; Slater and Gilbert 2004; Deegan, Cooper and Shelly 2006a). The relationship between non-financial factors and financial performance is stated succinctly in a PricewaterhouseCoopers report (Eccles et. al. 2001), *The Value Reporting Revolution: Moving Beyond the Earnings Game,* "To create long-term economic value for society—shareholders and other stakeholders alike—sustainability says that companies must also create social and environmental value." Additionally, companies including DuPont, Mobil, Allstate, Gap Inc. and British Petroleum-Amoco recognize the potential comparative advantages of publicly disclosing their goals related to non-financial and financial performance measures and then reporting on how well they achieve those goals (Ballou et al 2006). The demands for reporting on non-financial performance measures are not only growing, but they also relate to critical corporate value creation and risk assessments.

Corporate social responsibility has been an object of interest for academicians for several decades (Heald 1957, Ullmann 1985, Moir 2001). Social accounting in its contemporary form, which involves issuing a report on social performance of an organization, started in the 1970s (Gray 2000). A number of studies have examined various aspects of sustainability reporting. Among the topics investigated are worldwide trends and frequencies of sustainability reporting (Dawkins and Ngunjiri 2008, Kolk 2004), impact of issuing sustainability reports on financial performance (McWilliams and Siegel 2000, Baron 2001, Garriga and Melé 2004, Guenster et al 2005, Wagner-Tsukamoto 2007), socially responsible investing (Orlitzky et al 2003, Sparkes and

Cowton 2004, Hockerts and Moir 2004, Hellsten and Mallin 2006), regulation (Dowell et al 2000, Whitehouse 2006, Detomasi 2007) and assurance related to sustainability reporting (Kok et al 2001, Hasan et al 2003, Hasan et al 2005, Mock et al 2007, Hodge et al 2007).

Research concerning sustainability reporting assurance began in the late 1990s. The early studies included Nitkin and Brooks (1998) and Wallage (2000). During this period, a growing number of companies have started providing assured sustainability reports (Owen and O'Dwyer 2004, University of Amsterdam and KPMG Global Sustainability Services 2005, Deegan, Cooper and Shelly 2006b, Mock et al. 2007).

The significance of obtaining independent third party verification on sustainability reports has been acknowledged in the preceding literature. For example, Owen et al (2000) find that in the absence of a bona fide change in design and implementation of corporate governance structures, assurance services on sustainability reports may be controlled by special interest groups that may mold it into a competently crafted plan to promote a desirable image of the parties and activities involved. Ballou et al (2006) argue that the utility of sustainability reports diminish without independent third party verification. Gray (2000) reasons that good quality attestation is essential for reliability of information conveyed in sustainability reports to fulfill its role in developing transparency and accountability. He also adds that there has been no research into auditor's practices and concerns regarding the attestation of social data, but auditors have *de facto* responsibility for social and environmental reports that are published separately or as a part of financial statements.

Some institutions provide standards for publishing sustainability reports and others provide standards for assurance of sustainability reports. As mentioned above, standards for issuing sustainability reports and standards for assurance of these reports are not laws that are

required to be followed in any jurisdiction. The standards for publishing sustainability reports are meant to facilitate reporting by organizations on their social, environmental and economic performance. The standards for assuring sustainability reports are meant to be used by audit practitioners to verify the quality of information in the sustainability reports. We focus on assurance standards in this study. The important standards for assurance of sustainability reports are issued by the following institutions: International Auditing and Assurance Standards Board (IAASB), AccountAbility (AA), Nederlands Instituut Van Registeraccountants (NIVRA) and Social Accountability International (SAI).

The International Auditing and Assurance Standards Board (IAASB) has issued International Standard on Assurance Engagements (ISAE) 3000 (Oelschlagel 2005) and its purpose is to cover assurance engagements *other than* audits or reviews of historical financial information covered by International Standards on Auditing (ISAs) or International Standards on Review Engagements (ISAE 2005). The IAASB is an arm of International Federation of Accountants (IFAC) which serves the public interest by setting standards and working toward the convergence of national and international standards (IFAC 2009). ISAE3000 provides comprehensive standard on ethical requirements for practitioners, engagements and related issues, quality control, expert assistance in performing the engagement, obtaining evidence, documentation, preparing the assurance report, effective date and difference between levels of assurance (Rao, Mock and Srivastava 2009). However, ISAE3000 does not provide specific management assertions related to CSR assurance services.

AccountAbility is a global, non-profit, self-managed partnership founded in 1995 with bases in Beijing, Geneva, London, Sao Paulo and Washington D. C. and country representatives in Brazil, Canada, China, Jordan, Spain, Sweden and the US (AA 2009). AccountAbility is

responsible for the AA1000 series of standards of which AA1000 AccountAbility Principles Standard (AA1000APS) and AA1000 AccountAbility Assurance Standard (AA1000AS) are a part. The latter is used by practicing auditors to evaluate and provide conclusions on the nature and extent of adherence to the AA1000APS, and, where applicable, the quality of publicly disclosed information on sustainability performance. The AA1000AS includes guidelines on using the standard, accepting, planning, performing and reporting an engagement to the management and to the users of the sustainability report (Rao, Mock and Srivastava 2009). The AA1000AS does not list any management assertions related to CSR assurance services.

NIVRA, the Dutch accounting body, published the standard COS 3410N in 2007. This standard deals with assurance engagements relating to sustainability reports and discusses the scope and objective of providing assurance on such reports, engagement acceptance, risk analysis, system related products, substantive procedures, dealing with multi-locations, obtaining additional evidence, documentation and the assurance report itself. The NIVRA COS 3410N also does not list any management assertions related to CSR assurance services.

Social Accountability International (SAI) has developed the SA8000 standard, which specifies voluntary conditions to be fulfilled by employers in the workplace, and can be used by auditors to provide assurance. These conditions concern the workplace conditions, worker's rights and management systems and are founded on international human rights norms, national law and canons of the International Labor Organization. SA8000 also includes social accountability requirements such as child labor, forced labor, collective bargaining, discrimination and working hours. Similar to the other assurance standards described above, the SA8000 does not list any management assertions related to CSR assurance services.

In their paper, Mock et al (2007) examine the basic characteristics of 130 assured sustainability reports and find that companies from 21 different countries publish assured sustainability reports with the European Union providing 67% of the reports. Additionally, they find that firms operating in environmental and economically sensitive areas such as utilities, mining and oil provide the most assured reports and that 65% of the assured reports were audited by Non-Big 4 firms. Interestingly, unlike in an annual financial statement audit, they find that almost all of the audit firms disclose the procedures they performed.

Some researchers express concern about the audit expectations gap. Hodge et al (2007) describe the audit expectation gap as the lack of effective communication by an assurance report. Hasan, et al (2003) quote from a monograph commissioned by the International Federation of Accountants (IFAC 2002, i): "The accurate determination and effective communication of levels of assurance provided in assurance statements are critical issues for the well being of the profession and the future development of assurance services." Adams and Evans (2004) also emphasize the need for lucidity in the nature and level of assurance provided.

While all the above streams of research explore topics that are valuable in content and consequence, none of them analyzes the actual steps taken by a professional assurance provider to provide assurance for sustainability reports. In this paper, we demonstrate the use of the evidential reasoning approach for providing attestation to sustainability reports. The evidential reasoning approach provides a structured approach to the evidence collection and aggregation process related to assurance services. Most importantly, it supplies the assurance provider with a blueprint for aggregating evidence and facilitates scrutinizing the main objective, assertion, or sub-assertion to insure that evidence at a level desired by the assurance provider is obtained.

Depending on what has been found, the assurance provider can then perform further procedures or issue a report that reflects the existing situation.

The suggested approach to cost analysis should be of significant value in planning the audit procedures as well as estimating and minimizing the cost of the audit. Having knowledge of the lowest cost alternative will enable the assurance provider to concentrate on those audit procedures that will control audit risk and provide the needed level of confidence. We expand on these in subsequent sections.

3. EVIDENTIAL DIAGRAM

In the auditing contexts discussed in this paper, evidential reasoning entails determining what sort of evidence is relevant to the specific assertion being considered and deciding what level of support for the assertion is obtained from each item of audit evidence that is collected. To model such decision settings, an evidential diagram may be developed comprising of the variables involved in providing assurance along with their mutual relationships and items of evidence pertaining to those variables. Once the evidential diagram is completed, the auditor can judge the influence of available evidence on the variables, and thus assess the impact of any item of evidence on all of the assertions being audited.

In such models, knowledge about one or more variables can be used to make assessments concerning other variables, if we know how these variables are interrelated (Srivastava et al. 2005; Sun et al 2006). Normally, knowledge about the states of these variables is incomplete. That is, there is uncertainty associated with what an auditor knows about these variables. These uncertainties translate into the audit risks that must be controlled (Srivastava and Shafer 1992; Fukukawa and Mock 2011).

Underlying Framework

Since the assurance procedures recommended by international sustainability assurance standards (IAASB 2005, AA1000 2008, NIVRA COS 3410N 2009, SA8000 2008) are general in nature and provide little guidance about collection of items of evidence, and since most sustainability reports are made according to GRI guidelines, we use G3 (GRI 2006) guidelines to investigate the use of evidential reasoning for conducting a CSR audit. A company adopting sustainability reporting guidelines can use G3 guidelines in several ways with varying degrees of application.

For instance, they may choose to use them for *informal* compliance or to employ them in a series of consecutive partial implementations. Or, they may decide to give an account of their corporate sustainability achievements predicated on the stricter *in accordance* level[1]. The shift from *informal* to *in accordance* under GRI standards occurs through a greater degree of transparent reporting, expansion of reporting coverage across the company and a more developed reporting structure. G3 guidelines leave the decision to the company whether it issues reports in all three performance areas or in one or two of these reporting areas.

Table 1 lists the three major assertion categories that would need to be considered when providing sustainability reporting assurance: 'Social Assertions', 'Environmental Assertions' and 'Economic Assertions'. Table 1, column 1, labeled 'Main Assertions', describes the assertion categories. The related sub-assertions are listed in the second column.

According to the G3 guidelines, social assertion category reporting requires that the entity disclose all major impacts that it has on the social system within which it operates. This includes labor practices, human rights, social interaction, and product responsibility. These conditions are expressed as assertions in column 2 of Table 1 and in Figure 1. The assurance

[1] See www.globalreporting.org/Services/ReportServices/InAccordanceChecks/ .

provider will need to plan and collect adequate and pertinent evidence in support of each of these assertions. The sub-assertions are assumed to be related to the corresponding main assertions through an 'and' relationship. This relationship conveys that the main assertions are valid if and only if the corresponding sub-assertions are valid.

----- Table 1 about here -----

----- Figure 1 about here -----

Construction of an Evidential Diagram

Figures 1 and 2 illustrate the structure of evidential diagrams. First, all the assertions (the main assertion, sub-assertions, and sub-sub-assertions) and items of evidence pertaining to these assertions must be identified. To illustrate the process of constructing an evidential diagram consider Figure 2 where the assertions are depicted as rectangular boxes with rounded corners. The main assertion on the left (A1.1) states a 'completeness accuracy assertion'[2] that "All laws and company policies related to labor practices are being followed and are disclosed completely and accurately". This assertion is connected through an 'and' relationship, represented by a circle with an '&', to six sub-assertions. All sub-assertions and the corresponding main assertion are based on the G3 guidelines. The variables representing assertions and sub-assertions have values such as 'true' or 'false' which means that the assertion is valid (true) or not valid (false).

----- Figure 2 about here -----

Next, items of evidence pertaining to various assertions must be specified. These items of evidence result from audit procedures performed by the assurance provider. Rectangular boxes are used as evidence nodes to represent items of evidence and these items of evidence are connected to the assertion or assertions that they help inform. The key challenge in providing assurance is to plan and implement a minimum cost and effective set of procedures.

[2] Completeness and accuracy are used for illustrative purposes.

As mentioned earlier, in Figure 2, the six sub-assertions to the right of the main assertion are related to it through an 'and' relationship. This relationship suggests that the main assertion is valid or true if and only if the six sub-assertions are valid. In Figure 2, the evidential diagram drawn is a network diagram, that is a network where at least one item of evidence pertains to more than one assertion. In order to determine whether the main assertion is true, the assurance provider would plan and perform the procedures described in the rectangular boxes (evidence nodes). Each evidence node represents an audit procedure which provides positive, negative, or mixed evidence concerning the assertion to which it is linked. Based on what is ascertained from each of the procedures, the assurance provider can estimate the level of support or negation from each item of evidence for each corresponding assertion.

Following the syntax of DS theory, the first number in an assertion node is the level of support or belief that the assertion is true and the second number is the level of support or belief that the assertion is false. The third number shows the level of ignorance associated with each assertion. The procedures illustrated throughout the paper are intended to be comprehensive, but not exhaustive. That is, there could be other items of evidence that could be created using G3 guidelines. Our intention is to show how an assurance provider can use the evidential reasoning approach for planning and conducting a cost efficient CSR audit. First, in Section 4, we discuss how audit evidence propagates through a CSR evidential network such as that represented in Figure 2. Then in Section 5 we propose and illustrate a sequential planning process which allows the assurance provider to provide assurance at targeted levels of assurance and thus control audit risk at minimum cost.

4. EVIDENTIAL REASONING APPROACH ILLUSTRATION

In this section, the hypothetical case presented in Figure 2 is used to illustrate the evidential reasoning, that is the propagation of evidence required while performing a CSR assurance service. A similar example is then used in Section 5 to illustrate audit planning.[3]

First, we illustrate the propagation of strength of evidence in terms of m-values from sub-assertions to the main assertion which is *Complete and Accurate disclosure of Labor Practices* and is abbreviated as A1.1. Then we illustrate the propagation of m-values to a particular sub-assertion from the main assertion and all other sub-assertions. In particular, we choose Assertion A1.1.1: *Complete & Accurate disclosure of Conditions & Benefits of Employment* as the sub-assertion of interest. We use upper case letters to represent the name of the variables such as 'A1.1.1' for the assertion A.1.1.1 and lower case letters to represent their values. For example, 'a111' represents the situation where 'A1.1.1' is true and '~a111' the state where A1.1.1 is not true. Additionally, we label the evidence items with 'En' to signify the evidence number. Abbreviations and symbols used are listed in Table 2.

----- Table 2 about here -----

Combination of Audit Evidence Relevant to the Main Assertion

Consider first the propagation of strength of evidence from sub-assertions (A1.1.1, A1.1.2, … A1.1.N) to the main assertion (A1.1) (Figure 2). To simplify the computations, we transform the evidential diagram from a network structure to a tree structure[4] using the following process. Suppose we have evidence that pertains to two sub-assertions. We split this evidence into two different items of evidence relating individually to the two sub-assertions. For example,

[3] We assume that readers have basic background on the DS theory of belief functions (Shafer 1976) and thus we do not provide an introduction to belief functions. For such an introduction, see Yager et al (1994) and Srivastava and Mock (2002).

[4] Srivastava and Lu (2002) have demonstrated that a tree structured evidential diagram is a good approximation of a network structure.

in Figure 2, evidence E4 is linked to sub-assertion A1.1.1 and to sub-assertion A1.1.2. The partitioned input m-values are assumed to be as follows:

$m_{E4}(a111) = 0.7$, $m_{E4}(\sim a111) = 0.1$, $m_{E4}(\{a111, \sim a111\}) = 0.2$,

$m_{E4}(a112) = 0.7$, $m_{E4}(\sim a112) = 0.1$, $m_{E4}(\{a112, \sim a112\}) = 0.2$.

That is, we assume an equal amount of evidential support for the two sub-assertions. However, in general, one can choose different levels of support for each sub-assertion.

We combine multiple items of evidence at each sub-assertion using Dempster's rule as simplified by Srivastava (2005) to obtain updated m-values at each sub-assertion. Next, we use Srivastava et al (1995) to propagate the evidence impounded in the above m-values from the six sub-assertions to the assertion 'A1.1' through the 'and' relationship. Finally, we combine the above m-values propagated to 'A1.1' from the six sub-assertions with the m-values obtained from the evidence directly bearing on 'A1.1'. The resulting m-values are the updated belief masses at ‘A1.1’ given all of the audit evidence bearing on the six sub-assertions (i.e. E2, E3 … E9), the desired result.

To accomplish the steps described above, we programmed, in the Frontline Solver attachment to MS Excel Spreadsheet (Frontline System Inc. 2009), the logic for combining multiple items of evidence on a variable using Dempster's rule as modified by Srivastava (2005) and programmed the Srivastava et. al (1995) approach of propagating belief masses from sub-assertions to the main assertion.

Consider the following scenario for our illustration. Suppose an assurance provider is collecting evidence pertaining to sub-assertion A1.1.1 and plans and obtains three relevant items of evidence for A1.1.1, namely E2, E3 and E4 (See Figure 2). The assurance provider examines evidence E2, that is, reviews and recalculates payroll data and confirms minimum wages and pay

scales with a sample of employees. The auditor then decides that these procedures provide support for A.1.1.1 to the extent of 0.7 on a scale of 0-1 and no support for its negation with a resulting lack of knowledge of 0.3. In other words, these audit tests allow the auditor to be 70% confident that the client has complete and accurate disclosure of employment conditions and benefits. However, as the audit test provides no evidence to the contrary, thus there is still 30% ignorance.

The assurance provider then reviews benefits provided to full-time employees that are not provided to part-time employees (E3) and decides that these audit procedures provide evidence in support of A1.1.1 of 0.6. Again, the assurance provider does not find any evidence that provides negative support for A1.1.1. Here, the resulting level of ignorance is 0.4.

The assurance provider proceeds to review labor lawsuits to find out the number and cause of such lawsuits (E4) and decides that the evidence provides support in favor of A1.1.1 of 0.7 and provides negative support for A1.1.1 of 0.1, which leaves the level of ignorance to 0.2. In summary, the strengths of evidence assessed for E2, E3 and E4 are as follows:

$m_{E2}(a111) = 0.7$, $m_{E2}(\sim a111) = 0.0$, $m_{E2}(\{a111, \sim a111\}) = 0.3$,

$m_{E3}(a111) = 0.6$, $m_{E3}(\sim a111) = 0.0$, $m_{E3}(\{a111, \sim a111\}) = 0.4$,

$m_{E4}(a111) = 0.7$, $m_{E4}(\sim a111) = 0.1$, $m_{E4}(\{a111, \sim a111\}) = 0.2$.

These input m-values are based on the assurance provider's assessment of the evidence and judgment. Similarly, the assurance provider determines m-values for all other items of evidence as given in columns 3-5 in Table 3.

As mentioned earlier, the first step in propagating belief masses from the sub-assertions to the main assertion is to determine the total belief masses at each sub-assertion based on all items of evidence directly bearing on each sub-assertion. For example, using Dempster's rule,

the combined m-values of the three items of evidence, E2, E3, and E4, bearing directly on the sub-assertion A1.1.1 are m(a111) = 0.961, m(~a111) = 0.013, m({a111, ~ a111}) = 0.026. This means that when evidence E2, E3 and E4 are combined, the combined strength of evidence indicating that A1.1.1 is valid is 0.961, the combined strength of evidence implying that A1.1.1 is not valid is 0.013, and the combined ignorance about A1.1.1 is 0.026.

Similarly, we determine the total m-values at each sub-assertion as a result of combining all the items of evidence bearing directly on the sub-assertion using Dempster's Rule. These values are listed in columns 6-8 in Table 3.

Next, we use Proposition 1 of Srivastava et al (1995) to propagate m-values from sub-assertions to the main assertion A1.1. The combined strength of evidence at A1.1 propagated from the sub-assertions yields the following m-values: m(a11) = 0.521, m(~a11) = 0.101 m({a11, ~a11}) = 0.378.

The assurance provider has one additional item of evidence to consider, specifically E1 which provides direct evidence concerning A1.1: m(a11) = 0.7, m(~a11) = 0.0, m({a11, ~a11}) = 0.3. To determine the overall belief masses at the main assertion level, A1.1, as a result of combining all the evidence, we combine the belief masses obtained from E1 with the belief masses propagated from the sub-assertions, A1.1.1. – A1.1.6 (see Figure 2). This yields the following overall m-values: m(a11) = 0.846, m(~a11) = 0.032, m({a11, ~a11}) = 0.122 (see columns 9-11 in Table 3). This means that the combined audit evidence confirming the assertion that the organization completely and accurately discloses its labor practices is 0.846, the combined evidence disconfirming the assertion is 0.032 and the level of ignorance is 0.122.

----- Table 3 about here -----

The assurance provider can then use the above information to make a decision about

whether the 'Labor Practices' assertion is valid or not or whether additional evidence needs to be collected. In the illustration, the evidence confirming the assertion is a moderate level of 0.846, the evidence disconfirming the assertion is only 0.032, but the plausibility that the assertion is not valid is 0.154. If the Srivastava and Shafer (1992) plausibility definition of audit risk is used, the audit risk that the assurance is not true is 0.154 (i.e., 15.4%).

Given that the belief that the assertion is true is 0.846, the CSR assurance provider has two main alternatives. First, the auditor could conclude and report that the assertion is fairly stated at what might be considered a 'moderate' level of assurance. Or, the auditor could continue to collect audit evidence to the point where the plausibility of misstatement was much lower (it is conventional to use 5%). An approach to obtaining such evidence at minimum cost is discussed later in this paper.

A third possibility is to conclude that the evidence suggests that the assertion is not valid, but this would be unlikely given the evidence only supports a very small belief of 0.032 supporting such a conclusion. Given the low belief in misstatement, the auditor could opine that the main assertion is fairly stated at an acceptable level of audit risk; describe the nature of any observed deficiencies in labor practices; and identify specific areas the management should focus on to mitigate such deficiencies. CSR assurance standards and practices provide much more flexibility than conventional financial statement audit reports in what the auditors may communicate (Mock et al 2007; Mock et al. 2010).

Combination of Evidence at a Sub-assertion

Evidential networks are somewhat peculiar in that the information obtained at each node flows to all other connected nodes (Shenoy and Shafer 1990, and Pearle, 1990). To consider this aspect, we use sub-assertion A1.1.1: *Complete & Accurate disclosure of Conditions & Benefits*

of Employment – to exemplify the propagation of strength of evidence from assertion A1.1 and from the other sub-assertions to the chosen sub-assertion (A1.1.1). Again, we use Figure 2 to illustrate this.

The m-values from various items of evidence at the sub-assertions (A1.1.2, A1.1.3, A1.1.4, A1.1.5, and A1.1.6) and the assertion (A1.1) are given in Table 3. The input m-values are assumed to be based on the assurance provider's assessment of the various strength of evidence provided by each audit procedure as indicated in columns 3, 4 and 5.

As an example consider the following input m-values at A1.1 from evidence E1: $m_{E1}(a11) = 0.7$, $m_{E1}(\sim a11) = 0$, and $m_{E1}(\{a11,\sim a11\}) = 0.3$ (see row 1, and columns 3-5 in Table 3). We assume the assurance provider examines a sample of labor reports filed by the client and decides that they provide evidence in support of A1.1 to the extent of 0.7, as the labor reports are judged to have a good degree of objectivity and reliability. In the assurance provider's opinion, these labor reports provide no negative evidence for A1.1, leaving the level of ignorance about A1.1 to 0.3 given this particular audit test.

To determine the overall combined m-values at sub-assertion A1.1.1, three sets of m-values must be combined. One set comes from A1.1, another from the other sub-assertions, and the last set of m-values are defined at A1.1.1 originating from evidence E2, E3, and E4. We again use Dempster's rule and Srivastava et al (1995) to combine the above m-values.

The resulting overall combined belief masses at A1.1.1 are: $m(a111) = 0.988$, $m(\sim a111) = 0.004$, $m(\{a111,\sim a111\}) = 0.008$ (see columns 9-11 in Table 3). These values indicate that there is a very high degree of positive support for A1.1.1 (0.988) and almost no support for the negation of the sub-assertion (0.004). Given this situation, the assurance provider should be confident that the sub-assertion A1.1.1 is valid, could provide a high level of assurance with little

audit risk on this assertion, and thus would not need to perform any additional audit procedures. However, if the evidence provided less than the assurance provider's target acceptable level of belief, say 0.95, then the assurance provider should either perform additional procedures to obtain a higher level of assurance, qualify the opinion by listing any shortcomings or even provide a negative opinion of some sort suggesting that the assertion may not be 'fairly stated'. Again, CSR assurance provides a wide latitude of options (Mock et al 2007).

5. ASSURANCE PLANNING AND COST ANALYSIS

In this section, we develop and describe an approach that can be used by an assurance provider to plan the assurance engagement by identifying those procedures that provide the planned level of assurance at minimum cost and at an acceptable level of audit risk. Our approach begins with a general cost minimization model constrained only by the targeted level of assurance to be provided and an exponential cost function associated with each item of evidence to be collected. Then we consider constraints based on the inherent limitations of audit procedures. Finally, we consider the sequential, iterative nature of audit planning where plans are updated as audit evidence is obtained.

Again, we use Frontline Solver Attachment (Frontline System Inc. 2009) to MS Excel Spreadsheet to develop and illustrate the audit planning process. The current problem of cost minimization under constraints is a non-linear optimization problem. The 'Standard GRG Non-Linear Engine' of Frontline Solver Attachment has capabilities that would solve such a problem. To provide a planning context, consider the Figure 2 example of a part of a CSR assurance engagement. The planning challenge is to determine the audit program that will provide assurance on the main assertion of *Complete and Accurate disclosure of Labor Practices* at an acceptable level of audit risk and at minimum cost.

First, the assurance provider needs to decide on and document a target level of overall belief for each of the sub-assertions in order to give an unqualified[5] CSR assurance report which would state that the CSR is 'fairly stated' or something similar . Our illustrations assume that the target level of belief that the main assertion is true is with a belief of 0.90 or higher and that each sub-assertion is true is with a belief of 0.95 or higher. These targets imply that the assurance provider is willing to accept a 10 percent audit risk that the main assertion may not be valid and a 5 percent risk that each sub assertion may not be valid. We use the plausibility definition of audit risk as suggested by Srivastava and Shafer (1992) in our illustrations. However, the planning model may be used for alternative definitions of risk as described in Fukukawa and Mock (2011).

Given these targets, the assurance provider would then plan the nature, timing, extent and staffing of audit procedures expected to meet the targets. Depending on the nature, timing, extent and staffing of the procedures, some procedures may be less costly than others in obtaining the target levels of evidential support. For our analysis, we assume a cost function for each procedure, which increases exponentially as the target level of assurance achieved increases, or equivalently, as the acceptable audit risk decreases.

We assume the cost is bounded at each endpoint as follows. If the desired level of belief from the evidence pertaining to the corresponding assertion is zero (i.e., B = 0, where B represents the desired level of assurance measured in terms of the belief that the assertion is true), then the cost of performing the procedure is zero. Similarly, the cost is infinitely high if the target belief is certainty, that is, 1.0. Mathematically, such a cost function can be expressed as: Cost = aB/(1-Exp(-b(1-B)), where a and b are parameters that together determine the amount of

[5] In general, the CSR assurance provider has a variety of reports or audit opinions that may be provided (Maijoor et al. 2002). This contrasts with the financial statement auditor where standards are much more restrictive as to alternative reports.

cost and the rate at which the cost increases as the target assurance level, B, increases.

Figure 3 plots such a function with three sets of values for 'a' (a = $2,500, $5,000, and $10,000), and one value for b = 20. At a lower assurance level, the cost increases linearly as a function of the level of assurance B desired with a slope of 'a'. However, at higher level of assurance, the cost increases as a function of B, much more rapidly, with an increasing slope proportional to 'a' and inversely proportional to 'b' and risk squared, $(1-B)^2$. This makes logical sense because the incremental cost incurred by the auditor would be of the same order when the auditor plans to acquire more evidence to achieve an additional level of assurance say, 0.1, from 0.4 to 0.5 or from 0.5 to 0.6. Also, this additional cost would be expected to be much higher if the auditor increases the target level of assurance from 0.85 to 0.95. Our choice of parameters, 'a', between $2,500 and $10,000, and b = 20, is intended to reflect a reasonable set of values for the Figure 2 illustration and for the following scenarios.

----- Figure 3 about here -----

The assurance provider can use the evidential diagram in Figure 2 and the corresponding cost function as discussed above to plan for a desired level of overall assurance at a minimum cost. This is achieved by minimizing the total cost function for the planned level of belief (assurance) and associated risk in the main assertion and in each sub-assertion. The assurance provider may then specify additional constraints related to the nature of the audit evidence and procedures. These possibilities are illustrated in the following.

Cost Minimization

As noted earlier, the assumed cost function associated with each audit procedure is Cost = aB/[1-Exp(-b(1-B))]. In this cost function, B determines the level of assurance an assurance provider achieves through this item of evidence that a certain assertion or sub-assertion is true. In

our illustration, assume that the assurance provider plans the service to achieve at least 0.9 level of assurance for the main assertion (A1.1) and 0.95 level of assurance for the sub-assertions with known values of a and b for each procedure. The challenge is to determine the minimum cost set of audit procedures.

In those situations where a certain audit procedure pertains to more than one assertion, only the maximum cost of performing such a procedure is taken into consideration in our model. For example, in the Figure 2 illustration, evidence E4 is relevant to both sub-assertions A1.1.1 and A1.1.2. The cost function for E4 in our model is defined to be the maximum of the cost of performing E4 for A1.1.1 and for A1.1.2. That is, the Cost of E4 equals the maximum of {Cost of E4 for A1.1.1, Cost of E4 for A1.1.2}.

Since we have nine items of evidence in Figure 2, we need to minimize the sum of all nine cost functions. Thus, the objective function to minimize the total costs of the assurance engagement for the assertions depicted in Figure 2 can be written as:

$$\text{Minimize: Total Cost} = \sum_{i=1,2,3,5,6,8.9} (\text{Cost of Ei}) + \text{Max}\{\text{Cost of E4 for A1.1.1, Cost of E4 for A1.1.2}\} + \text{Max}\{\text{Cost of E7 for A1.1.3, Cost of E7 for A1.1.4}\}, \quad (1)$$

where cost of evidence Ei is given by $a_i.B_i/[1-\text{Exp}(-b_i(1-B_i)]$.

We begin our investigation of this minimization problem by assuming it is subject to the following constraints:

1. There is a minimum target level of assurance for each assertion, i.e., $B_i \geq B_{i\text{-min}}$.
2. The belief masses from each item of evidence for the corresponding assertion or sub-assertion are assumed to be positive, i.e., $0 \leq m_{Ei}(x) \leq 1$, and $m_{Ei}(\sim x) = 0$ and the sum of belief masses from each item of evidence pertaining to an assertion must add to one as required by DS theory, i.e., $m_{Ei}(x) + m_{Ei}(\sim x) + m_{Ei}(\{x, \sim x\}) = 1$.

We use the 'Standard GRG Non-Linear Engine' of Frontline Solver Attachment (Frontline System Inc. 2009) to MS Excel Spreadsheet to minimize the above cost function by

varying the input belief masses from all the nine items of evidence. This provides a baseline solution, labeled Scenario 1, as discussed below (See Table 4).

The results for Scenario 1 in Table 4 suggest that the minimum cost set of procedures in this case is to perform just the procedures related to evidence E1 to obtain 0.95 level of assurance for assertion A1.1 and not perform any other procedures. Since this is least costly procedure, the total cost of this audit is only $3,757. This is a logical result under the assumptions.

Since evidence E1 is at the main assertion level, A1.1, the information about the assertion A1.1 being true can be propagated back to the sub assertions. This suggests that all its sub-assertions are true with the same level of assurance. Since we assumed the auditor desired at least 0.95 level of assurance for all the sub-assertions of A1.1, and 0.9 level of assurance for A1.1, a 0.95 level of assurance for A1.1 should meet all the requirements. That is, all the sub-assertions are true at 0.95 level, and the main assertion A1.1 is true at least 0.90 level of assurance (in fact, A1.1 is true at 0.95 level of assurance).

However, this is not a realistic situation for most audit contexts. The above result is obtained under the assumption that all the items of evidence are equally reliable and can provide a maximum of 1.0 level of assurance for the corresponding assertion or sub-assertions. However, in practice, some items of evidence may be less reliable and hence provide a lower level of support for the corresponding assertion or sub-assertion. The reliability of evidence depends on the nature, timing, and extent of the procedure performed. We discuss such scenarios next.

Including Constraints Representing the Inherent Nature of the Audit Evidence

An interesting finding from the previous analysis is that, if the auditor assumes each audit procedure has the potential to provide essentially unlimited assurance, the minimum cost audit program is one that emphasizes procedures which directly provide assurance on the main assertion A1.1. However, in practice it has been found to be essentially impossible to find and implement such procedures, certainly at reasonable cost. Thus in practice, limitations are placed on the maximum reliance on procedures which reflect the inherence limitations on the evidence (Bell et al. 1997).

For example, the procedure in Figure 2 that bears directly on the main assertion A1.1 is to vouch (verify the accuracy of) a sample of the labor reports the client files with local or state governments. The inherent limitations of such a procedure include sampling error if a complete sample is not verified and the ability to actually obtain copies as such documents may be confidential in certain jurisdictions or may be incomplete. Such limitations are reflected in an additional constraint we now add to the cost minimization formulation:

3. The maximum level of support that can be expected from each item of evidence is assumed to be a given level less than 1.00 based on the competency and sufficiency of the evidence.

We consider three additional scenarios to illustrate the application of our planning approach and the effects of alternative situations on the minimum cost audit program and the expected maximum support from various items of evidence.

Scenario 2: Again, assume the assurance provider has specified a minimum acceptable level of overall belief (i.e., assurance) that each assertion and sub-assertion is true. As in the prior illustrations, assume it is 0.95 for all sub-assertions and 0.90 for the main assertion. Sensitivity analysis can be used to evaluate the effects on the planned audit program and on minimum cost

of changing these thresholds.

Assume also, consistent with constraint #3, that the assurance provider establishes the maximum level of support (an 'upper limit' on assurance) that is expected to be obtained from each item of evidence as follows: E1: 0.7, E2: 0.8, E3: 0.8, E4 (for A1.1.1): 0.95, E4 (for A1.1.2): 0.9, E5: 0.9, E6: 0.9, E7 (for A1.1.3): 0.8, E7 (for A1.1.4): 0.95, E8: 0.95, E9: 0.95. These could be based on the auditor's prior experience with the inherent nature of these procedures adjusted to the particular SCR client.

The next step would be to estimate the cost of obtaining each item of evidence. As noted, wherever one item of evidence is connected to more than one variable, the model considers the highest cost.

Determining the cost of each item of evidence involves estimating two parameters, 'a' and 'b', whose values depend on the nature and extent of the procedure performed. An assumed set of values for 'a' and 'b' are given in Table 4 for each item of evidence for scenarios 1 and 2. These scenarios apply constraints 1 and 2 and thus assume only positive audit evidence. Scenario 2 differs from scenario 1 in that a limit is placed on the expected reliance that can be placed on E1 of 0.70.

[Insert Table 4 about here]

The results of Scenario 2 in Table 4 demonstrate the following. First, it is not possible to get the desired level of assurance on the main assertion, A1.1, and its various sub-assertions just by gathering evidence E1 because of its assumed reliability maximum of 0.70. Other items of evidence must be gathered in order to meet the desired level of assurance at each assertion/sub-assertion and consequently the minimum cost of the audit is significantly higher, that is $51,568, compared to $3,757 for scenario 1.

Note also that procedures related to evidence E2 and E5 are not needed. The reason for this is that E4 is needed to satisfy the minimum assurance of 0.95 for sub-assertion A1.1.1 along with E3 and E1. Since E4 is necessary for A1.1.1, it is most efficient to use E4 for sub-assertion A1.1.2. A 0.9 level of assurance from E4 for A1.1.2 along with 0.7 from E1 for A1.1 is enough to yield 0.95 level of assurance for A1.1.2, the required minimum. Thus, there is no need to perform audit procedure E5 for A1.1.2.

Scenario 3: Subsequently, suppose the assurance provider determines that the maximum level of assurance that is appropriate from E1 cannot be more than 0.5 because certain jurisdictions have declined to provide the requested documentation. In such a situation, a change in the cost minimization problem is required to decrease the maximum level of assurance for E1 from 0.7 to 0.5. Note that this decrease applies to an audit test at the main assertion level.

We summarize the effects of this change by comparing Scenarios 2 and 3 (see Tables 4 and 5). This one change brings about the following complex set of changes:

1. The cost of conducting E1 decreases from $1,754 to $1,250 because the level of support needed from E1 decreased from 0.7 to 0.5, which is the maximum that could be obtained from E1 in Scenario 3.

2. The cost of E2 increased from $0 (procedures not being performed) to $3,858 because the needed assurance increased from zero to 0.765.

3. The cost of E3 decreased from $3,915 to $3,858 because the needed assurance decreased from 0.774 to 0.765.

4. The cost of E4 (linked to A1.1.1) decreases from $10,409 to $8,312 because the needed level of support from E4 (linked to A1.1.1) decreases from 0.90 to 0.812.

5. The cost of E4 (linked to A1.1.2) decreases from $10,409 to $8,446 because the needed level of support from E4 (linked to A1.1.2) decreases from 0.90 to 0.821.

6. The cost of E5 increased from $0 to $7,399 because the needed level of support from E5 increased from zero to 0.864.

7. The cost of E6 increases from $5,367 to $6,245 because the needed level of support from E6 increases from 0.85 to 0.90.

8. The cost of E7 (linked to A1.1.3) remains unchanged at $8,149, because the needed assurance from this evidence for A1.1.3 remained unchanged. The cost of E7 (linked to A1.1.4) increases from $11,237 to $13,457 because the needed level of support from this evidence increased from 0.916 to 0.940.

9. The costs of E8 and E9 increase significantly from $9,443 to $12,023 because the needed level of support from E8 and E9 increase from 0.924 to 0.95.

10. The total cost of the assurance engagement increases significantly from $51,568 in Scenario 2 to $68,558 in Scenario 3.

Here we observe that a decrease in the maximum level of support obtained from E1 at the main assertion level brings about a significant increase in the total cost from $51,568 to $68,558. This result suggests that, in order to minimize the total cost of an engagement, the assurance provider should work to obtain more reliable evidence at the higher level of assertions. Evidence at the overall assertion level exerts a larger influence on the costs and the needed level of support from the other items of evidence pertaining to the sub-assertions. In practice, auditors do place more effort in assessing the evidence at the overall level (e.g., see Bell et al. 1997, p 14) than evidence at the sub-assertion level. Our results provide analytical support for such practices.

Scenario 4 (Mixed Evidence): To further evaluate the sensitivity, we next consider the case of mixed evidence. Suppose that, due to finding significant weaknesses in accounting control systems within the client's disclosure of labor practices, the auditor assigns a low level of support, say 0.1, to the negation of assertion A1.1. Thus, the assessment of the results of E1 is (0.7, 0.1, 0.2) which represents a mixed evidence case. This change brings about the following changes in the minimum cost solution (See Table 5):

1. The costs of E2 and E3 increase from $3,858 to $3,991 because the needed level of supports from E2 and E3 increase from 0.765 to 0.787.

2. The cost of E4 (linked to A1.1.1) decreases from $8,312 to $8,071 because the needed level of support from E4 (linked to A1.1.1) decreases from 0.95 to 0.808.

3. The cost of E4 (linked to A1.1.2) increases from $8,446 to $9,374 because the

needed level of support from E4 (linked to A1.1.2) increases from 0.821 to 0.869.

4. The cost of E5 increases from $7,399 to $7,702 because the needed level of support from E5 increased from 0.0.864 to 0.878,

5. The costs of E6 and E7 (linked to A1.1.3) remain unchanged at $6,245 and $8,149, respectively because the needed level of support from E6 and E7 (linked to A1.1.3) remained unchanged.

6. The cost of E7 (linked to A1.1.4) increased from $13,457 to $15,029 because of the needed level of assurance increased from 0.94 to 0.95.

7. The costs of E8 and E9 remained unchanged at $12,023 because of the needed assurance from E8 and E9 remained at the same level as in Scenario 3.

8. The total cost of this part of the assurance engagement increased from $68,558 to $71,627.

[Insert Table 5 about here]

As seen above, the impact of a negative piece of evidence at the main assertion level, especially at a low level, the minimum cost process yields a set of procedures where certain procedures are performed at a higher level of assurance while some at a lower level assurance, ultimately yielding a higher minimum audit cost. However, if the negative evidence is strong then we may not get a feasible solution. This scenario is discussed next.

Updating the optimal audit plan as evidence is collected

The prior scenarios are assumed to pertain to an early stage in a CSR assurance engagement when an initial audit plan in being developed. As it is a plan, and as in most audits, as evidence is actually collected the plan must be revised. For example, the plan may assume the evidence related to E1 will be primarily positive with only minimal negative evidence. We illustrate an approach to addressing such a case in Scenario 5.

Scenario 5: Subsequently, suppose the assurance provider determines that the management is not reporting accurately issues related to sub-assertion A1.1.4 “Complete and

Accurate disclosure related to Occupational safety" and thus assigns 0.4 level of assurance to the negation of A1.1.4;that is $m_{E7}(\sim a1.1.4) = 0.4$.

For this situation, we cannot find a minimum cost solution because it is not possible to achieve the required minimum threshold of assurance for all of the assertions given that the auditor has strong negative evidence about one of the sub-assertions. Such a situation may arise either due to inherent weaknesses in the occupational safety reporting system or due to intentional management fraud in reporting.

In such a situation, the assurance provider has several options. For example, if the problem is due to inherent weaknesses in the occupational safety reporting system, then the assurance provider can propose changes in the management report. If such changes are made, an unqualified report on this part the audit is appropriate. However, if management is unwilling to change the report, then the assurance provider could possibly issue a qualified report for this part of the audit. Many other reporting and action options are available including, if the problem is judged to be due to management fraud, withdrawing from the engagement.

6. SUMMARY AND CONCLUSION

This study focuses on both theoretical and applied aspects of sustainability reporting assurance services. We have demonstrated the use of an evidential reasoning approach based on the Dempster-Shafer theory of belief functions for CSR assurance services. We use the G3 sustainability reporting guidelines issued by GRI to develop the evidential diagrams for our illustrations.

At the applied level, we develop an assurance planning and cost analysis framework. This framework takes into account the target acceptable audit risk that each assertion and sub-assertion is not valid and the cost of each audit procedure. The framework allows the assurance

provider to concentrate on those procedures that provide the planned level of assurance for each assertion of interest. This equips the assurance provider with a powerful tool that can be used to plan an assurance service in order to minimize the cost of the service.

This paper contributes to both the sustainability literature as well as to the auditing literature. Our study is not only the first one to view sustainability reporting assurance from the perspective of an evidential reasoning schema, but also the first to put forward a framework which determines the minimum cost of an assurance service or audit engagement using DS theory. Thus, the framework enables an assurance provider to concentrate on those audit procedures that provide cost-effective assurance.

Since this paper is the first attempt to apply the evidential reasoning approach to the assurance of sustainability reports, there are limitations as well as opportunities for future research. Our models likely do not identify all of the relevant variables or associated items of audit evidence. Future research, especially performing case studies, can improve the evidential network by identifying omitted assertions and relevant evidence. We also use DS theory to represent uncertainties in the CSR setting. Future research should examine the empirical ramifications of using this approach.

This paper is also the first attempt to develop a framework that allows an assurance provider to estimate and minimize the cost of the service. The cost function used in the study is a hypothetical function and involves some potentially restrictive assumptions such as the assumption that the audit procedures usually provide confirming evidence. Future research should explore other possibilities and also explore and incorporate cost functions based on empirically derived cost functions.

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Table 1: Assertions and Sub-assertions for Sustainability Reporting Services

Main Assertions	Sub-Assertions
A1. Social reporting assertion: The organization fairly presents all major impacts that it has on the social system that it operates in.	**A.1.1: Labor Practices -** Complete and Accurate disclosure of Labor Practices**.** The organization fairly presents its labor practices and whether it meets internationally recognized standards.
	A1.2 Human Rights: The organization fairly presents the extent to which human rights plays a part in its operations and activities.
	A1.3 Social Interaction: The organization fairly presents the major risks that arise from interaction with other social institutions.
	A1.4 Product Responsibility: The organization fairly presents how its products and services directly affect customers.
A2. Environmental Reporting assertion: The organization fairly presents its performance and all major impacts that it has on the environment that it operates within.	**A2.1 Materials:** The organization fairly presents the extent to which it uses different materials by weight and by volume and the percentage of materials used that are recycled input materials. **A2.2 Energy:** The organization fairly presents the extent to which it consumes energy by energy source. **A2.3 Water:** The organization fairly presents the extent to which it withdraws water by source. **A2.4 Biodiversity:** The organization fairly presents the location, size of land owned, leased, managed in or adjacent to protected areas and areas of high diversity value, description of significant impacts of activities, products and services on biodiversity in protected areas and areas of high biodiversity value. **A2.5 Emissions, Effluents and Waste:** The organization fairly presents total direct and indirect greenhouse gas emissions by weight, emissions of ozone-depleting substances by weight, NO_x and SO_x and other significant air-emissions by type and weight, total water discharge by quality and destination, total weight of waste by type and disposal method, total number and volume of significant spills. **A2.6 Products and Services:** The organization fairly presents initiatives to mitigate environmental impacts of products and services and the extent of impact mitigation, percentage of products sold and their packing materials that are reclaimed by category. **A2.7 Compliance:** The organization fairly presents monetary value of significant fines and total number of non-monetary sanctions for non-compliance with environmental laws and regulations.
A3. Economic Reporting assertion: The organization fairly presents its economic performance	**A.3.1 Economic Performance:** The organization fairly presents direct economic value generated and distributed, which includes revenues, operating costs, employee compensation, donations, community investments, retained earnings and payments to capital providers and governments, coverage of the company's defined benefit plan obligations and significant assistance received from government. **A3.2 Financial Performance:** The organization fairly presents financial implications, risks and opportunities, of the organizations activities due to climate change. **A.3.3 Market Presence:** The organization fairly presents policy, practices and proportion of spending on locally based suppliers at significant locations of operation, procedures for local hiring and proportion of senior management hired from local community at significant locations of operation. **A.3.4 Indirect Economic Impacts:** The organization fairly presents development and impact of infrastructure investments and services provided primarily for public benefit through commercial, in-kind or pro-bono engagement.

Table 2: List of Symbols and Their Descriptions

Assertion and Sub-Assertion	Description of Assertion and Sub Assertion	Evidence/Related Assertion[s]	Audit Procedure
A1.1	Complete and Accurate disclosure of Labor Practices	E1/ A1.1	Vouch a sample of client labor reports with both local and state governments and review for completeness.
A1.1.1	Complete & Accurate disclosure of Conditions & Benefits of Employment	E2/A1.1.1	Review and recalculate payroll data and confirm with employees about employee minimum wages and pay scales
A1.1.2	Complete & accurate disclosure of Labor & Management Relations	E3/A1.1.1	Review benefits provided to full time employees that are not provided to part time employees.
A1.1.3	Complete and accurate disclosure related to Occupational health	E4/A1.1.1 & A1.1.2	Review labor lawsuits to find out the number and the cause of such lawsuits
A1.1.4	Complete and accurate disclosure related to Occupational safety	E5/A1.1.2	Review contractual obligations of management towards labor unions to determine whether the company respects collective bargaining.
A1.1.5	Complete and accurate disclosure related to Employee education and training	E6/A1.1.3	Conduct surprise inspections of facilities and sites for evidence of working conditions
A1.1.6	Complete and accurate disclosure related to Diversity and equal opportunity in the company.	E7/A1.1.3 & A1.1.4	Review number of on-site injuries and other illnesses to determine occupational health and safety.
		E8/A1.1.5	Review labor education and training policy and confirm with employees to determine implementation.
		E9A1.1.6	Determine number of employees from different ethnic groups and sex and review promotion policy to determine equal opportunity.

Table 3: List of Input m-values and Overall m-values. The Assertion and Sub-Assertions along with the Corresponding Items of Evidence are defined in Table 2.

Assertion and Sub-assertion	Item of Evidence Pertaining to Assertion or Sub-Assertion	Positive	Negative	Θ*	Total m-values as a result of combining all the evidence directly bearing on the assertion and sub-assertions			Overall m-values		
					Positive	Negative	Θ*	Positive	Negative	Θ*
A1.1	E1	0.7	0	0.3	0.7	0	0.3	0.846	0.032	0.122
A1.1.1	E2	0.7	0	0.3	0.961	0.013	0.026	0.988	0.004	0.008
	E3	0.6	0	0.4						
	E4	0.7	0.1	0.2						
A1.1.2	E4	0.7	0.1	0.2	0.895	.0.058	0.047	0.966	0.019	0.015
	E5	0.7	0.1	0.2						
A1.1.3	E6	0.7	0	0.3	0.935	0.032	0.32	0.979	0.010	0.011
	E7	0.8	0.1	0.1						
A1.1.4	E7	0.8	0	0.2	0.8	0	0.2	0.935	0	0.065
A1.1.5	E8	0.9	0	0.1	0.9	0	0.1	0.968	0	0.032
A1.1.6	E9	0.9	0	0.1	0.9	0	0.1	0.968	0	0.032

* The values in the column with heading Θ represent ignorance about the corresponding assertion or sub-assertion

Table 4: Sensitivity Analysis: Scenarios 1 and 2 with the Cost Parameter b =20.

Evidence number	Assertions Evidence is Linked to	Cost Para-meter 'a' ($)	Scenario 1			Scenario 2		
			Upper limit on assurance belief	Level of support needed in Min. Cost Solution	Cost ($)	**Upper limit on assurance belief**	Level of support needed in Min. Cost Solution	Cost ($)
E1	A1.1	2,500	1.0	0.95	3,757	0.70	0.7	1,754
E2	A1.1.1	5,000	1.0	0	0	0.80	0	0
E3	A1.1.1	5,000	1.0	0	0	0.80	0.774	3,915
E4	A1.1.1	10,000	1.0	0	0	0.95	0.900	10,409
E4	A1.1.2	10,000	1.0	0	0	0.90	0.900	10,409
E5	A1.1.2	8,000	1.0	0	0	0.90	0	0
E6	A1.1.3	6,000	1.0	0	0	0.90	0.850	5,367
E7	A1.1.3	10,000	1.0	0	0	0.80	0.800	8,149
E7	A1.1.4	10,000	1.0	0	0	0.95	0.916	11,237
E8	A1.1.5	8,000	1.0	0	0	0.95	0.924	9,443
E9	A1.1.6	8,000	1.0	0	0	0.95	0.924	9,443
					$3,757			$51,568

Table 5: Sensitivity Analysis: Scenarios 3 and 4 with the Cost Parameter b =20.

Evidence number	Assertions Evidence is Linked to	Cost Para-meter 'a' ($)	Scenario 3			Scenario 4 (mixed evidence)		
			Upper limit on assurance belief	Level of support needed in Min. Cost Solution	Cost ($)	Upper limit on assurance belief	Level of support needed in Min. Cost Solution	Cost ($)
E1	A1.1	2,500	**0.50**	0.5	1,250	**0.50**	0.50	1,250
E2	A1.1.1	5,000	0.80	0.765	3,858	0.8	0.787	3,991
E3	A1.1.1	5,000	0.80	0.765	3,858	0.8	0.787	3,991
E4	A1.1.1	10,000	0.95	0.812	8,312	0.95	0.794	8,071
E4	A1.1.2	10,000	0.90	0.821	8,446	0.90	0.869	9,374
E5	A1.1.2	8,000	0.90	0.864	7,399	0.90	0.878	7,702
E6	A1.1.3	6,000	0.90	0.900	6,245	0.90	0.90	6,245
E7	A1.1.3	10,000	0.80	0.800	8,149	0.80	0.80	8,149
E7	A1.1.4	10,000	0.95	0.940	13,457	0.95	0.95	15,029
E8	A1.1.5	8,000	0.95	0.950	12,023	0.95	0.95	12,023
E9	A1.1.6	8,000	0.95	0.950	12,023	0.95	0.95	12,023
					$68,558			$71,627

Figure 1: Assertion, sub-assertions, and sub-sub assertions related to an entity reporting on its performance in the Social Category. Sub-sub-Assertions A.1.1-A1.1.3 are described in Table 2

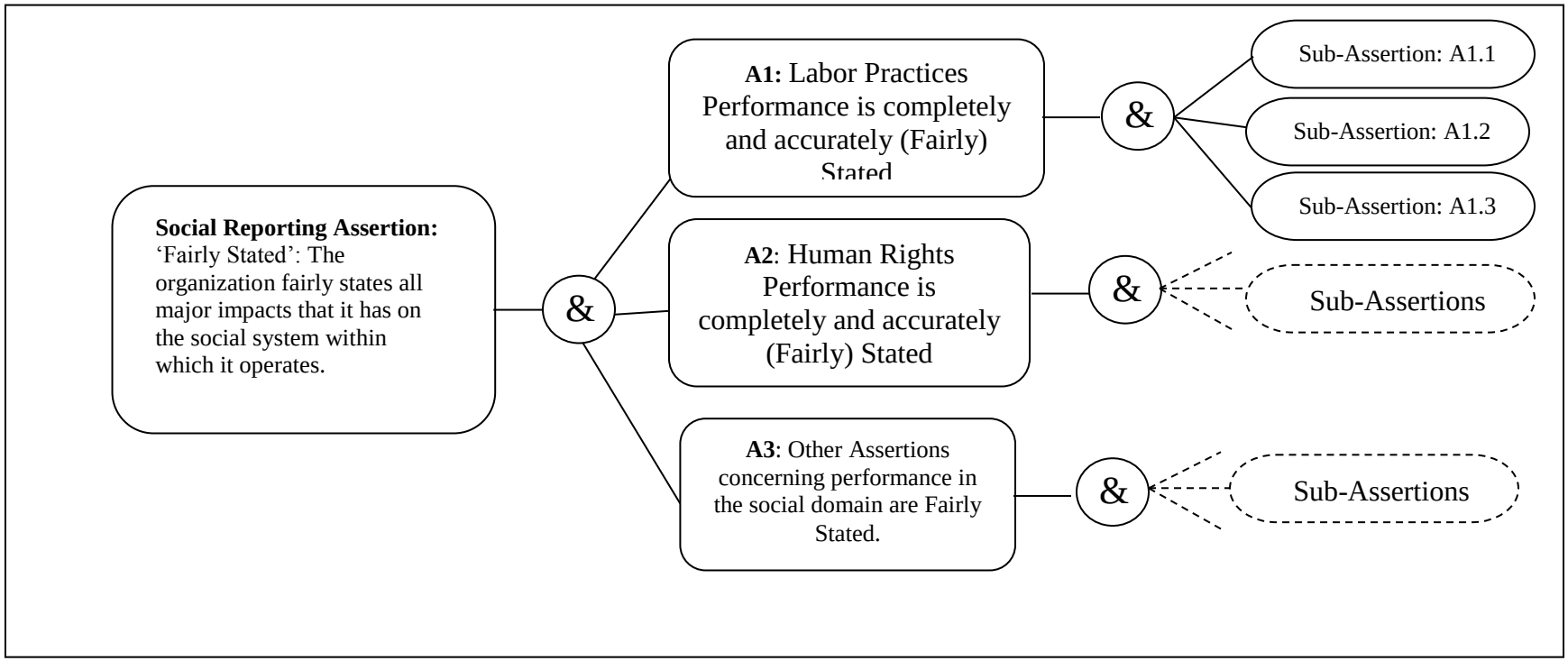

Figure 2. Evidential Diagram for Social Assertion Category **A1.1**: Labor Practices Performance is completely and accurately (Fairly) Stated

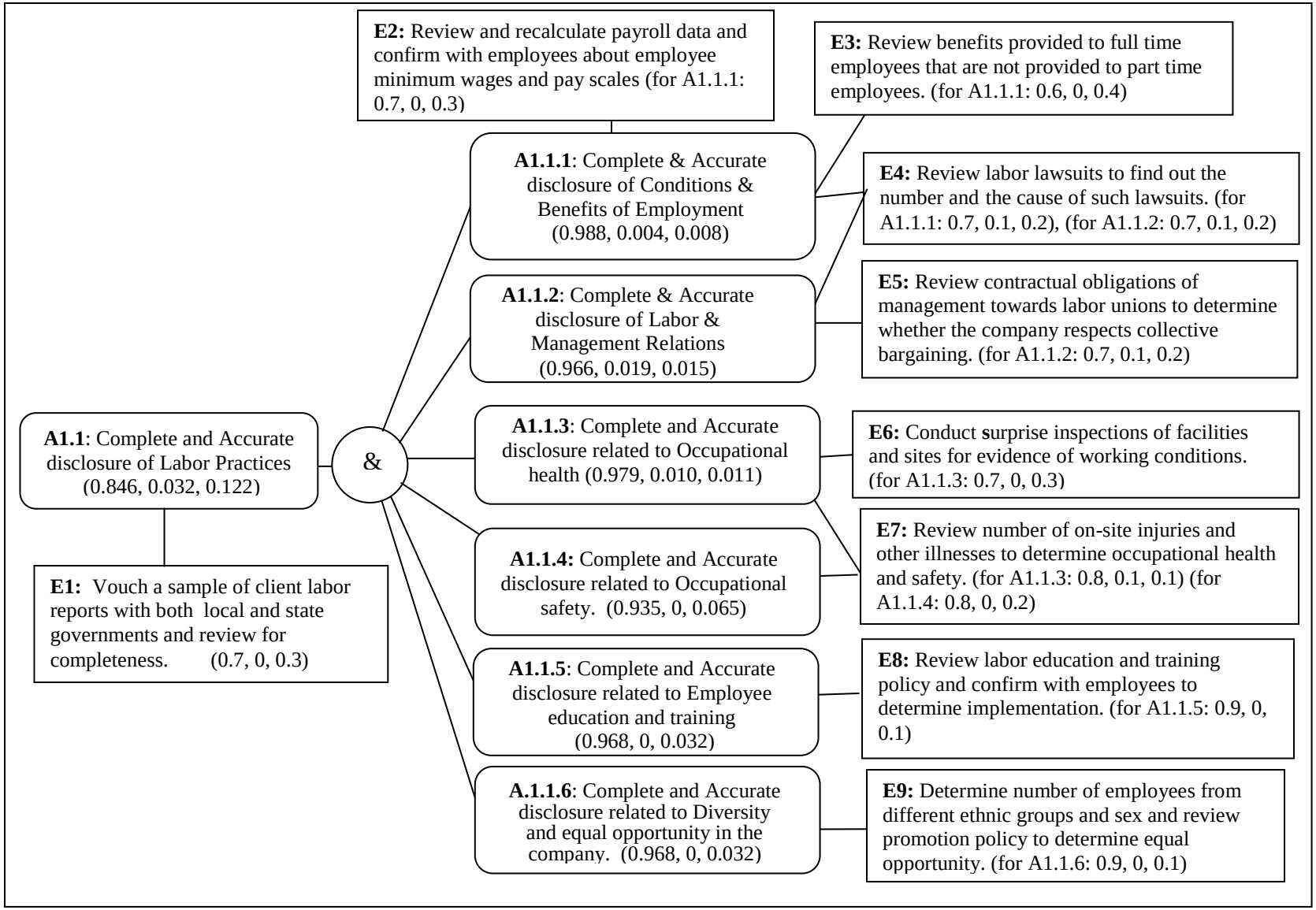

Figure 3. Cost Function Cost(B) = a*B/(1 - exp(-b(1-B)) with b = 20 for an audit procedure. B represents the level of assurance, and a and b together determine the level of cost and rate at which cost increases.