

A Measurement Theory Perspective on Business Measurement

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ABSTRACT: During the last five centuries, the traditional accounting model has evolved into a wide set of business practices and measurement conventions. In general, these models have served business well, but are now gradually losing relevance. The Public Company Accounting Oversight Board (PCAOB) (2011) consideration of a more informative audit report and the Financial Accounting Standards Board (FASB) (2011) reconsideration of a more precise concept of income clearly illustrate a growing disconnect with the traditional model. This paper explores the possibility of enhancing financial reporting with a wider frame of business representations and measures. It begins by discussing business measurement from the perspective of measurement theory, and then considers the potential that contemporary information technology and data processing offers by providing more relevant, timely, and reliable financial information. For example, some of the possible changes could be implemented through modified XBRL tagging.

In this paper, we discuss the limitations of the current reporting system and propose a generic business measurement model that includes three layers: the disclosure value chain, the point measurement of each datum, and the level of desired contingency measurement. The disclosure value chain includes environmental conditions, business plans, lead actions that augment current business activities measurement and, where feasible, information on consequent events. In examining the point measurement of each datum, we argue that measures often are not deterministic, but are contingent on time factors, the nature of the decision being supported, the level of desired precision, related

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future events, and inherent uncertainty. We present two structures combining these parameters. Finally, our explorations suggest that the level of the desired contingency measurement determines the appropriate information structure and that this measurement is needed in each specific decision context.

Keywords: financial reporting; theory of measurement.

INTRODUCTION

This paper applies concepts based on measurement theory and information economics in order to revisit some critical issues in entity financial performance measurement, as provided by accounting information systems. The framework of the current accounting model has been in place for over five centuries, since Luca Pacioli's introduction of the double-entry system.¹

Financial performance measurement initially evolved from basic business needs and was geared to the internal management of manufacturing entities. While it supported basic processes such as inventory management and sales recording, it also supported summary financial reporting, which facilitated performance measurement and accountability reporting to many stakeholders, such as investors. However, its capabilities were restricted by the technology available at the time it was developed.

Two basic developments have molded the evolution of the reporting model: the ever-increasing complexity of business processes and the recent dramatic changes in information technology. At the same time, the development of modern social-economic societies has increased the resources needed, such as transportation systems and security resources. Such social assets require relevant, valid, reliable, and verifiable forms of measurement to measure wealth, income, and other attributes of enterprises, and to develop equitable taxation systems.

The effects of the increased complexity of business processes and the dramatic advancements in information technology permeate the business environment, leading to rapid change and, hence, emphasizing the increasing insufficiency of the current obsolete methods of business measurement and regulations. Evidence of this insufficiency is the continuing criticism regarding the accuracy and assurance of financial reporting and assurance. The PCAOB (2011) consideration of an alternative audit reporting model and the FASB (2011) reconsideration of the concepts of income illustrate the perceived restrictions of the traditional model.

Three basic groups have different information and measurement needs: internal management, external investors, and government regulators (including taxing authorities), all of whom have exerted influence during the evolution of entity reporting and business measurement. Unfortunately, this evolution has been haphazard, and while a modern society could not have evolved without such useful business, not-for-profit, and governmental measurement processes, many of these processes failed to detect serious reporting and assurance transgressions (e.g., the Enron and Arthur Andersen bankruptcies) that have cost society significant resources.

Alles and Vasarhelyi (2007) discuss some difficult, perhaps intractable, problems inherent in the current accounting system. All of these problems have been extensively "addressed, but not resolved, by both standard setters and researchers." They include:

- Aggregation issues: The boundaries of business organizations are fuzzy, financial statements differ across industries, and the resulting measures often are not comparable or additive.

¹ Pacioli, L. 1494. *Summa de Arithmetica Geometria Proportioni e Proportionalita*.

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Traditional financial statement accounts include summaries of transactions, along with assumptions and estimates made by management.

- Reliability issues: Current methods produce numerical assignments that are unreliable, time dependent, and also not additive (e.g., property, plant, and equipment purchased at different times). Furthermore, the measurements that are provided lack transparency concerning their level of reliability. While some measures are reasonably accurate (e.g., cash), others are of questionable reliability, to the point of being irrelevant (e.g., goodwill).
- Completeness issues: There is lack of disclosure of relevant business features, such as contractual obligations.
- Valuation issues: Elements are valued based on obsolete economic situations and there is little disclosure of the contingencies in these valuations.
- Scale issues: Verbal descriptions of accounting phenomena are used when quantitative scales are feasible. For example, a firm specifies in a footnote that "certain contracts" may force "write downs on inventory," instead of giving the values of such contracts.

Given that such issues continue to perplex the accounting profession, this paper attempts to reconsider them from two basic perspectives. We begin by discussing business measurement from the perspective of measurement theory, and then by considering the potential that contemporary information technology and data processing offers in providing more relevant, timely, and reliable financial information. The result is a somewhat unique viewpoint that may provide a useful perspective for future research and development.

SOME BASICS OF MEASUREMENT THEORY

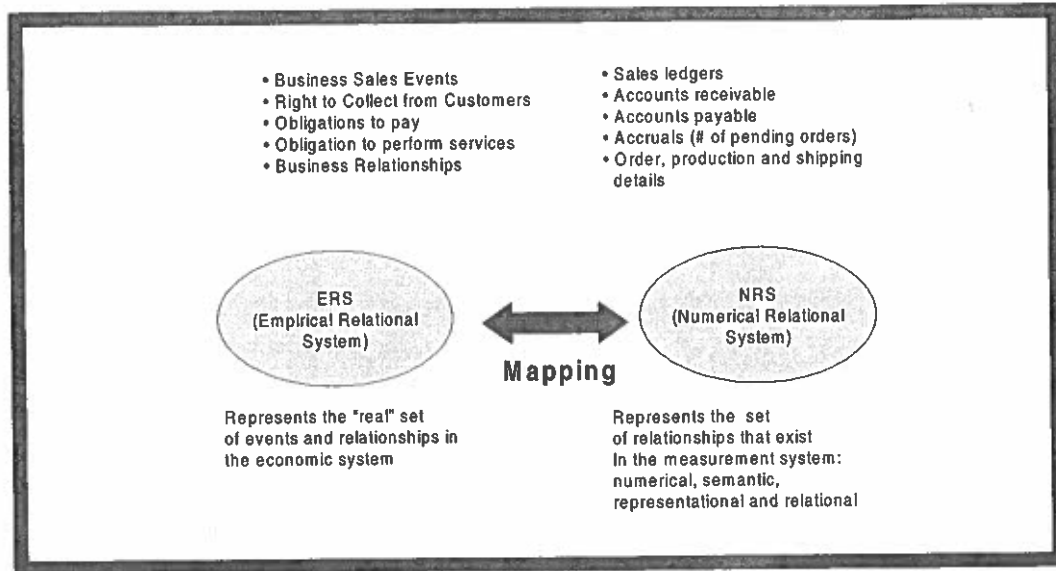
Mock and Grove (1979, 3) define a measurement system as "a specified set of procedures that assigns numbers to objects and events with the objective of providing valid, reliable, relevant, and economical information for decision makers." Formal measurement theory is based on mathematics; in particular, set theory, where a set of numbers is assigned to different attributes of phenomena of interest via a mapping process. For example, for deciding on an appropriate dividend payment, a dollar value may be assigned to an important entity resource (cash on hand at the time of the decision) to help determine how large of a dividend may be distributed. For some items, such as cash, the dollar value is an appropriate measure; however, for other items, there are other attributes that may serve as a better measure. For instance, inventory items may be better described by measures such as quantity on hand.

In this paper, we argue for a substantial extension of traditional external reporting by not only modifying the procedures of assigning values to objects, but also enhancing the declarations that describe the underlying events. This change is enabled by the presence of relevant data (e.g., purchase payment commitments and information about other existing contracts that would facilitate deciding on an appropriate dividend payment) within currently existing Enterprise Resource Planning systems (ERPs), such as SAP and Oracle.

To consider the potential of applying basic measurement concepts within current business information systems such as ERPs, it is necessary to summarize some of the basics of measurement theory. Mock (1976) discussed these in an accounting context beginning with the relationship between an Empirical Relational System (ERS) and a Numerical Relational System (NRS). The basic measurement constructs are represented in Figure 1, which shows an ERS being mapped into an NRS.

The ERS represents the objects (e.g., resources) and events (e.g., economic transactions) to be measured, as well as the relationships between these objects and events. It is clear that the timing of events as they relate to specific resources has an impact on their reported value. In the current business model, some stock flow relationships, as defined by McCarthy (1982), are summarized as a single value on financial statements. This assignment of value produces, for example, in the

FIGURE 1
A Basic Measurement System



valuation of inventory on hand, that the reported number depends on the choice of valuation methods, such as LIFO or FIFO. This high-level summarization makes the usefulness of information about the resource difficult for many decision models. For example, the same stock flow relationship can be characterized in alternative ways and requires different valuation methods for dissimilar decision situations. For example, a valuation of variable cost is relevant for some production decisions, while a valuation of total cost might be relevant for profitability analysis, or a valuation of the level of obsolescence may be applicable for capital budgeting decisions. Recent fair value discussions and standards show a plethora of potential fair values for a particular measurement.² Where feasible and economical, such attributes need to be captured (measured), stored, and communicated to various stakeholders.

The NRS includes a set of numerals and a set of fundamental numerical relations, for example, the "less than" (<), that are defined for the particular scale being used. The particularities of the ERS determine which scales are valid.

Given the ERS and NRS, the measurement system assigns numbers in the NRS to represent attributes of interest in the ERS, in a process referred to as numerical mapping. In formal measurement, this mapping requires a unique number be assigned to each object or event, which represents an attribute of interest (e.g., "incremental cost"), and requires that the assignments be homomorphic. To be homomorphic, the mapping must preserve the actual relationships in the ERS. For example, the construct "variable cost" is mapped with a unique number representing the variable cost; the construct "total cost" is mapped with a unique number representing the total cost,

² It has been suggested that fair values have contributed to recent market collapses and, as a result, the FASB, as well as the International Accounting Standards Board (IASB), have undertaken their review. There are, however, countervailing opinions. Decision-based valuations, as proposed later in this paper, might provide better information in such situations.

such that the relationship between the actual attributes is the same as the relationship between numbers. If the mappings are valid, then the variable cost measure will be "less than or equal to" the total cost measure.

Therefore, consideration of the underlying theory of business measurement leads to a number of dilemmas and challenges. Some of these are discussed in the following paragraphs.

COST ATTRIBUTES VERSUS VALUE ATTRIBUTES

Cost attributes are the base of the traditional external reporting structure. Mattessich (1964, 162) states that the cost basis is the most reliable method if the purpose of accounting is the presentation of data that can be verified at a comparatively "high degree of objectivity." He also discusses how the difficulties in quantifying value defined as marginal utility led to an indirect measurement of value through the price paid for a commodity. Importantly, while cost attributes are unique given the type of cost being measured, measures of values vary, as they are dependent on factors like time and are contingent on changes in the measuring scales, as well as on circumstances (Mattessich 1964, 163).

The following characteristics of value, some of which relate to the qualities of relevance as defined by Staubus (1970), need to be included to achieve meaningful levels of measurement.

Values are Time-Dependent

Many business measurements are time-dependent and are considered on an *ad hoc*, decision-dependent basis. For example, while cash is expressed in current-day amounts, other items have values that are affected by changes in prices. For example:

- A/R and A/P include debts with 30, 60, and more due days and do not include discounts or present values. The probability of collection on current paper is much larger than on, say, 60+ receivables.
- Inventory includes purchases over time, leading to LIFO, FIFO, and standard cost valuations.
- All financial paper is affected by existing and changing interest rates. The longer the maturity period, the stronger this effect may be.
- Advanced financial derivatives present an even more complex effect due to time-dependent changes in asset values. The acquired value of a put or call oscillates and, in general, reduces close to its expiration.
- Retained earnings measures aggregate accumulated dollars with very different values.

New business measurement models should be formulated with these issues in mind. For example, approaches such as a spreadsheet representation of company wealth and income flow can be made time-dependent and can provide interest rate sensitivity information.

Values are Contingent on Information Usage

The literature has been prolific in establishing valuation bases for business. For example:

- Exit value for liquidation situations (Parker 1975; Chambers 1979; Mock and Collins 1979).
- Present value of future cash flows for investors (Staubus 1971; Ijiri 1979; Sloan 1996).
- Market value for trading situations, for natural resources (Harris and Ohlson 1987; Barth 1991, 1994).

These alternate valuation bases are contingent on a particular view of business. Alternatives include maintenance of capital, maintenance of purchasing power, maintenance of purchasing

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FIGURE 2
Measurement Precision

Should we add them together?

Business reporting item	Precision
Cash	99%
Receivables	95%
Inventory & PP&E	75%
Intangibles	Not specifiable

82

capacity, and value for liquidation. Each of these valuation methods presents challenges in terms of optimization of the evolving technologies for their measurement.

Values are Contingent on Level of Precision

Measurements are of limited relevance if their precision is not clearly defined. In the physical sciences, the degree of precision is often explicit. For example, a weather forecast of precipitation may include its level of precision, while a measure of pressure will include the measuring tool used (e.g., barometer) or the measuring units (e.g., Pascals) that indicate the precision of the measure.

In contrast, the level of precision for many accounting values is determined not only by the aggregation of values from events that occurred at different points in time, but also from their procedural components as well. For example, reported values for accounts receivable not only includes a netting of sales based on cash receipts, but management then adjusts this net value for those receivables that might become uncollectible. Fixed asset valuations include estimates of useful life and residual value, which are in themselves the result of procedures conducted by management. Thus, the numerical value on a financial statement has a level of precision (or lack thereof) influenced first by the procedures used to obtain the starting value, and then further affected by the precision of management's estimates.

Traditional financial statements combine measures with different levels of precision, making an accurate assessment problematic. Figure 2 displays different Assets disclosed in the Balance Sheet as an example of the level of precision of their measures. Different Assets are reported and aggregated into the accounts without consideration of the precision of each measurement. Furthermore, assets valued with varying levels of precision and with differing measures are added together to form a Total Assets amount that likely is not representative of the real resources of the entity.

Values are Related to Future Events

A measurement related to a future event may have its value affected by features of various future events. For example, a credit sale's value is subject to the probability of collection; hence, a

FIGURE 3
Probabilistic Representation

Account	Value	Standard Deviation	Distribution
Cash	13500432	450000	Normal
Inventory	25000800	1000810	Normal
Sales	15890746	20056781	Normal

low-quality item or an item that is outperformed by a competitor's offer is likely to be returned instead of being paid. During the financial crisis of 2008, entire categories of assets were devalued by third-party defaults, which left standard setters at loss for a proper base of valuation.

Values are Linked to a Probability Distribution via an ERS/NRS Mapping

Populations of elements in the ERS data may be mapped into an NRS by statistical distributions that provide a more complete representation than simple point estimates. Therefore, in the current reporting environment, where tagged data are distributed separately from its originating environment, probabilistic descriptions may be more appropriate than deterministic ones. If these measurements are updated in real time, a more dynamic picture of the company will be available, which may reduce the amount of information needed for decision-making. For example, most decisions will be made using data distribution profiles, not raw data, and users of financial information will be able to rely on the latest reports without the need of looking back at historical information for trends. In this scenario, a set of accounts may be represented as described in Figure 3.

RELEVANCE VERSUS RELIABILITY

Staubus (1970) defines useful financial measures as those relevant to decisions. He presents a series of premises to evaluate the relevance of different measures of assets to investors and managers. Those premises highlight the differences of information needed by internal and external users for decision-making. While investors and other external users need to rely on the information disclosed, the benefits and costs associated with these disclosure activities are of additional interest to managers and internal users. He also highlights the need to produce information that is worth more than it costs.

Staubus (1970) identifies different qualities of relevance:

1. Activity relevance requires that the measurement reflect an activity of concern to the decision-maker.
2. Entity relevance requires that the measurement be related to the entity whose asset is being measured.
3. Place relevance requires that the measurement take into account the location of the asset.
4. Time relevance requires that the measurement reflect the existence of the property at the time of measurement.

There is always a trade-off between relevance and reliability, since "reliable measurements of perfectly relevant properties are rarely available" (Staubus 1970, 44) and, furthermore, GAAP has been characterized as conservative. The reason for GAAP's caution is partly a result of the influence of the public accounting and auditing profession. Auditors, concerned with the risk of

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litigation, have influenced the FASB³ to focus on reliability as opposed to relevance. As a result, many financial statements are still based on historical cost.

Due to this preference for conservatism, many GAAP measures may be reliable, yet also irrelevant for most decision needs. For example:

- The balance of retained earnings after a few years becomes a residual value that compares assets to liabilities, but which is not meaningful in a measurement theory sense.
- In a complex capital structure, the capital at par value is meaningless, even if the purpose is to establish the number of outstanding shares.
- Paid-in surplus has little decision relevance a few years after it is recorded.
- Most financial instruments are not fully adjusted to current market conditions on a day-to-day or even year-to-year basis, even if the instruments have a robust secondary market.
- Effects of keeping unproductive cash or large amounts of short-term receivables and liabilities with no associated interest are not measured at all.
- Since historical investment cost is not representative of value, financial ratios become misleading, both in measurement theory and in a decision perspective. It also reduces the relative comparability of statements of companies of different age (older companies, other things equal, will show higher returns on investment).

In order to deal with these issues, it would seem to be desirable to change the primary measurement objective from that of verifiability (reliability) to one of decision relevance, so that, for example:

- Retained Earnings represents the real accumulation of earnings adjusted for time value of currency and reflects relative value changes of corporate assets.
- Capital received from the stockholders is represented with only one number, and additional information (like original exchange and fair value) is presented in a statement of capital contributions.
- All financial instruments are measured on a continuous basis and revalued at market rates, with a separate part of the owner's equity reflecting this constant change.

SOME UNDERLYING ASSUMPTIONS OF THE BUSINESS REPORTING MEASUREMENT MODEL (BRMM)

Another interesting consideration is the underlying assumptions of the current BRMM:

- If something cannot be reliably measured with "objective" measures, it is not disclosed. Examples include the value of contracts, social obligations, and social assets.
- If a business event is prior to the actual "sale" (defined in an accounting sense), it is an event that is not captured, measured, and reported.
- External reporting is costly and, therefore, we should be restrained on what we report.
- One report and measurement format suffices for all external users.

Changes that Call to Question the Underlying Assumptions

The technology of business measurement, such as sensors, ERPs, and relational databases (Vasarhelyi et al. 2010), has substantially changed the environment of business reporting. Furthermore, business and user needs and motivations have evolved in the modern society, leaving

³ The FASB historically has been dominated by ex-members of the Big Auditing firms. Every chair of the FASB up to the present has been an ex-partner of a major firm. The EITF that deals with secondary GAAP issues is also dominated by these firms.

us with a reporting model that does not keep pace with or take advantage of this evolving environment. For example:

- Users of business information are comprised of many diverse interested parties. Yet, the BRMM is primarily investor-centric. The objectives chapter of the SFAC 8 reaffirms that investors and creditors are the primary users of financial information. Hence, employees, localities, and business partners are highly disadvantaged, as they are not considered to be critical users.
- Many variables that could not be measured before due to a lack of statistical methodology, a lack of historical databases, or a lack of interactive communication with customers can now be measured. For example, websites selling air tickets, raw materials, or merchandize inventory present current values and availability for many traded items.
- An increasingly larger group of stakeholders and their need for prospective instead of retrospective information has changed the user's requirements and, hence, how the BRMM should be presented.
- The economics of reporting have changed. The incremental cost of new disclosures is substantially reduced by synchronizing this reporting with the ERP systems. Since manual manipulation of data is not required, the incremental cost of repeating a report from the dataflow is close to zero.

Past Business Formulation Challenged by Current Business Practices

Figure 4 places business measurement in a sequential frame where past business formulation, planning, and action planning are contrasted with current business measurement and post-sales business actions. Time and value are highly intertwined due to the following factors:

- All business inherent events are time-dependent, including currency (time tagged).
- There is a time value of resources, but this value is dependent on other factors:
 - The ongoing basic risk-free value of resources,
 - The risk level of the entity, and
 - The risk level of the specific activity if separable from the measurement of the entity.
- The feedback loop of monitoring and control introduces the latency (Vasarhelyi 2006) of business administrative action (e.g., adjustment in the nature of inventories, adjustments in staffing, improvements in the logistic chain, procurement of additional financing, etc.).

In summary, inflation and risk perception (spread on interest) make measures heterogeneous. Adding three values with the same nominal amount three years in sequence is actually adding three different purchase powers. Furthermore, taking one interest rate for discounting across several years is a major simplification, as risk perception will change the actual price/return discounting rate every period.

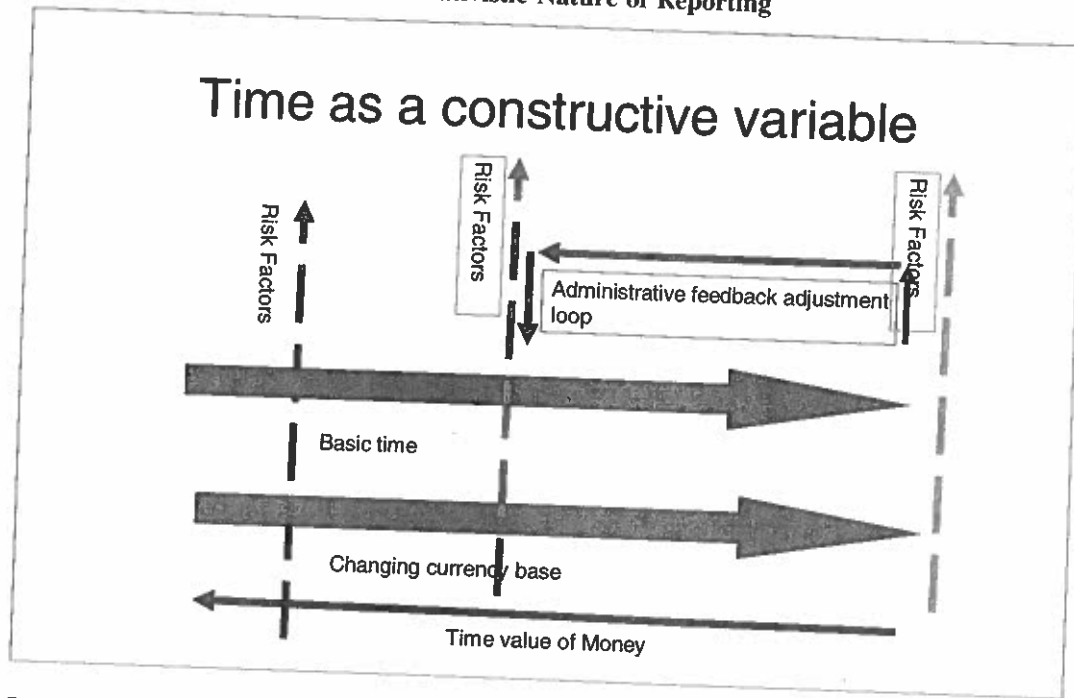
The risk of industries and governments and business activities changes with time and is often directly affected by interest rates and margin spreads. For example, the European currency crisis made government debt that had previously seemed manageable now suddenly impossible to sustain over a limited period of time.

Because of these time-related considerations, the role and types of BRMM are different from the prospective and retrospective views.

The REA structure expresses business activities at three levels (Geerts and McCarthy 2001). The first level reflects those activities from the past and near present. Most traditional reports made to external stakeholders are based on these activities. Financial statements and tax returns are summarizations of these activities with mainly external stakeholders in mind. There are also

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FIGURE 4
The Relativistic Nature of Reporting



activities in the past that do not find themselves on reports to external stakeholders, but are useful for internal users and management decisions. For instance, vendors are evaluated on their ability to match deliveries to the terms of negotiated agreements. When unfulfilled, these agreements form the basis of the next level of the REA ontology.

The second level of the REA structure is termed "the planned foreseeable future." These commitments can be formal, such as a contract, or as informal as management's schedule for production. Activities such as purchase orders to vendors, sales orders from customers, and production schedules are examples of these activities that become part of the "Negotiation" phase events. Communicating these activities is crucial, as they impact the need to acquire assets and anticipate requirements on the current infrastructure of the organization. Taken together, these planned future needs form the basis for future accounting business events and serve as an expectation for these events.

The third level includes those activities related to policies. Examples include those activities related to setting production standards, to establishing credit policies, and to creating job descriptions and responsibilities. These policy and planned future events never find their way to any reports to stakeholders, but clearly have an impact on the reports that do become available.

Given the differences between these views, it is important to present them separately. Hence, from a procedural perspective, the use of tagged information with its attributes (*a la*, e.g., XBRL),⁴ with a macro schemata to specify the attributes, as described later in this paper, may serve for this purpose.

⁴ See: <http://www.xbrl.org>

Extending Levels and Flows to Time-Related Measurements

The physical sciences have shown us that examining the dynamics of processes provides substantial insight into their nature. The BRMM tries to do the same by providing comparative retrospectives and some disclosure of trends. Learning from physical science measurements can be applied to the BRMM, both in the nature of time measures as well as the form of their representation.

Similar to researchers measuring air movements, in addition to temperature, pressure, and humidity, to understand the nature of tornadoes or produce forecast maps, if the BRMM provides measures of past behavior (sales, costs, inventory turnover, customer satisfaction, etc.) and future trends (employee benefits, government regulations, active actions to improve the environment by reducing emissions, etc.), a model can be built to understand the nature of the business and project what will happen in the future.

From an investor perspective, if we can measure the fixed and variable costs of an airline, the cost of airplane leases, the cost ramifications of contracts, the number of cancellations, the number of pilots and assistants operating and their levels of expertise, the extent to which the company is actively trying to help the environment by using less contaminating fuels, and evaluate the performance of competitors, then we can build a model and estimate future revenue of the airline company by only having the amount of tickets sold. Furthermore, this model could be extended to support different decisions.

The Three Layers of Entity Measurement

We divide the proposed measurement model into three layers by which to examine it within the context of measurement theory. These layers, which include declarations and procedures, are:

- (1) the disclosure value chain, where different stages of organizational activity are measured,
- (2) the point of measurement of each datum, where the nature attributes and specification of tags are captured, and
- (3) the level of desired contingency measurement, where the nature of different "virtual"/subjective business events and the trade-offs relative to their measurement are captured.

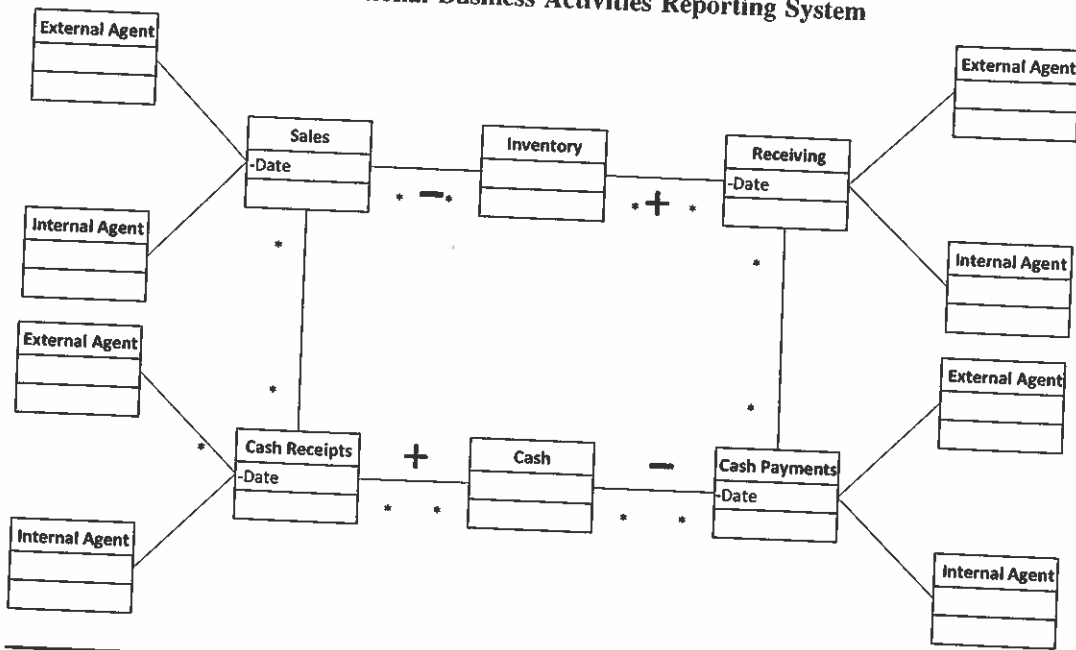
THE DISCLOSURE VALUE CHAIN (DVC)

In this section, we present a representation of the business process and discuss its different stages, the potential and benefits of their measurement, and the intrinsic issues related to measurement.

The business activity measurement process (represented in Figure 5) has developed over the years, focusing on the entity transactions from the moment of the sale and affecting mainly inventory and cash. The agents performing the transaction, both internal and external, were recognized to the extent that they participated in cash receipts or disbursements. Furthermore, the boundaries of the measurement process were defined as the entity being considered. External agents were only included to the extent that they participated in events being measured for financial statement purposes.

The main driver influencing the development of this approach was the needs of the business, and the main limitation was the technology, cost, and complexity of the process. Following the initial recording technology (Pacioli 1514), elements such as Property, Plant, and Equipment and Depreciation were added to represent the increasing complexity of business. For example, changing from an all-cash set of transactions to sales on credit required the development of receivables and payables. The development of more complex financial instruments, such as commercial paper, bonds, and stocks, required adaptations of the measurement model. Business practice drove the

FIGURE 5
The Traditional Business Activities Reporting System

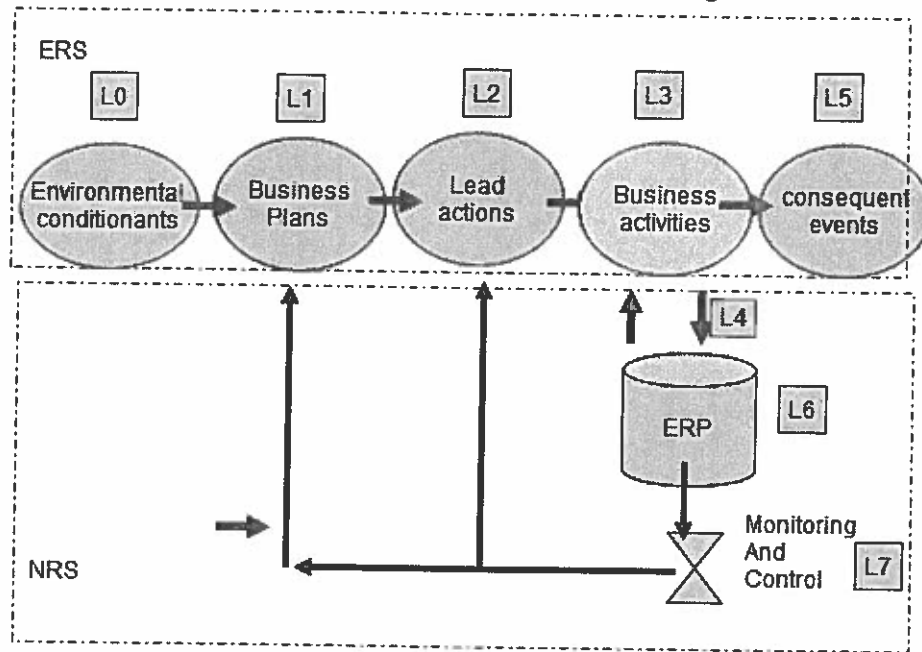


development of new elements of the measurement model, with business practice preceding accounting and limited by the existing technologies. Another change in the model was produced by the development of financial markets to facilitate better allocation of capital. The reporting malfeasance of the early 20th century created the Securities Acts of 1933 and 1934, which led to the need of standardization of business measurement, and the ensuing actions by the Accounting Principles Board (APB), FASB, and other regulatory entities. However, the modified Pacioli (1514) model that was created with the major technological limitations of 500 years ago is still the fundamental stone of business measurement.

The increasing complexity of business processes and the henceforth ensuing complexity of its measurement, plus the development of improved technologies of computing, forced the adoption of new measurement methodologies. A plethora of government regulations progressively formalized existing practices into rules that increased comparability, but without a structured plan, these rules became anachronistic and consequently led to inaccurate business measurement.

In recent years, the computational technology basis of the measurement process has evolved with the usage of integrated software such as ERPs. This development allows for evolution of multiple process measurements, integration of these measures, and most of all, nearly costless incremental capture of information. The incorporation of improved computational technology, the existence of improved analytic methods, and above all, the demand from more complex processes in a dynamic society (*Economist* 2002) lead to the need for expansion of the business measurement model into a more comprehensive set of related measures. Figure 6 presents a more enhanced view of the business process aimed at expanding its measurement scope. The model presents eight levels (L0 to L7), which depict key activities related to business measurement systems. Two additional issues should be noted: (1) ERPs contain vast amounts of information of a nonfinancial nature that

FIGURE 6
Business Activity Measurement, ERPs, and Monitoring and Control



allow for larger scope measurement, and (2) the current model is single-entity, leaving open the possibility of conjoint measurement⁵ of different entities.

We break down the general view of business into four different stages: (1) the early business stages, (2) lead actions, (3) business activities, and (4) consequent events.

Since Business Activities (L3) is the level at which measures are already defined (with the limitations due to the weaknesses of the existing reporting model mentioned before), we use this level of information to illustrate the application of the measurement model.

Mock and Grove (1979) define five steps needed to analyze existing or new measurement systems. These steps consider both the "factual view" of whether the measurement mapping is valid, and the "purposive view" of whether the mapping is cost effective:

1. Identify the decision context and related measurement needs. This step requires the identification of relevant cost-effective information needed for decision-making.
2. Identify the attributes of interest and postulate corresponding relationships. In cash estimate collections, we need to identify attributes like total sales and discount conditions, as well as relationships like percentage of customers who benefit from those discounts.
3. Investigate existing measurement scales from the factual view. This involves applying validity and reliability procedures to existing scales in order to ensure that the relationship between attributes in the ERS is maintained in the NRS. For many situations, there is flexibility in the scales that may be used. However, if equivalent scales are not unique, their relationship depends on the scale type (nominal, ordinal, interval, ratio) (Mock and Grove

⁵ Business entities have fuzzy boundaries, and complex modern organizations (e.g., SPEs) add to this problem.

TABLE 1
Information Needs, Corresponding Attributes, and Measures

Decision Needs	Attributes	Measures
Inventory needs	Sales orders in units	Units
Potential cash collections	Dollar value of sales	Historical cost
Net cash available	Present value of cash accounts	Present value
Accounts receivable—Bill?	Dollar value of sales and collections	Historical cost
Loss due to obsolescence	Cost and present value of inventory	Historical Cost/Present Value

1979). They also describe that in measurement theory terms, same-type scales are related to one another following admissible transformations (e.g., interval and ratio scales are additive).

4. Construct and analyze formal characteristics of new measurement scales for the factual view. This step is needed in case measurement scales for the identified attributes do not exist or need to be improved. These scales then need to be evaluated using validity and reliability procedures.
5. Analyze each scale from the purposive view. The measures developed have to be evaluated in terms of the information needs. For example, do the measures developed in steps 3 and 4 facilitate the information needs detected in step 1 in a cost-effective manner?

Table 1 includes examples of information needs, corresponding attributes, and measures in the business activity level (L3).

Environmental Conditions (L0)

While the classic entrepreneurship literature focuses on the start of business from scratch, a business is a dynamic entity with many starts and environmental considerations. Furthermore, organizations need to assess themselves regularly and understand the interactions of their components under changing conditions.

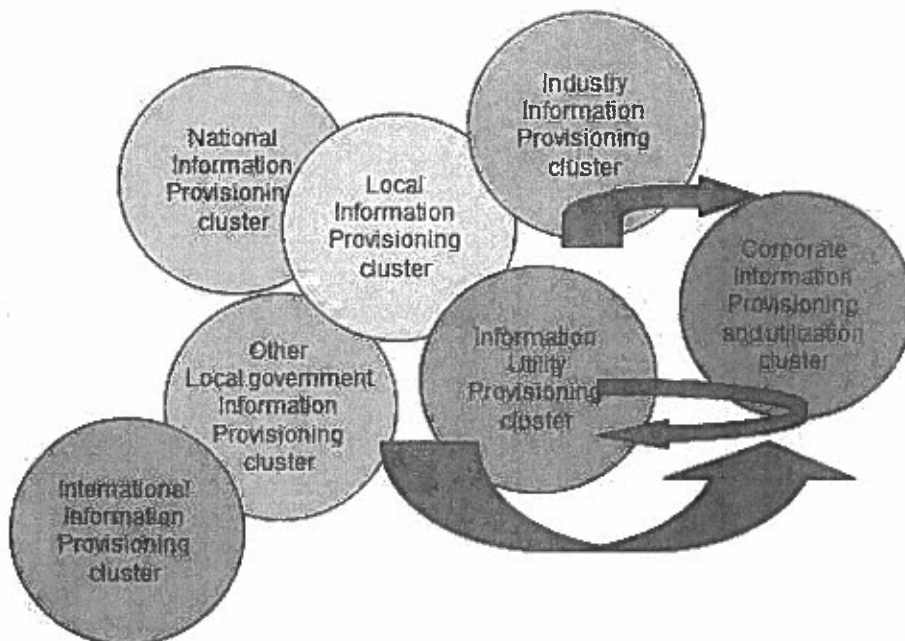
With the change in information processing technology and the progressive interdependence of societal informational clusters, the question arises concerning the desirability and feasibility of formalization of measurements in L0. The wider net of statistical and macroeconomic information at this level is provided by national governments and supplemented by lower levels of government. These information clusters are now progressively being complemented by industry group information and electronically collected information during trading (Figure 7). The formalization of these information clusters and their integration into organizational decision-making is a progressive set of steps in the expansion of corporate measurement systems. Among the environmental conditions (L0), we find macroeconomic variables, resources available, business ideas, licenses, and permits.

Progressively, the societal information clusters become more integrated and formal, leading to feedback loops with the different types of organizational information systems. The measurement view of business will eventually formalize and integrate these information flows into earlier levels (L0).

The subsequent levels of the model in Figure 7 can be mapped to the phases defined in ISO for the REA ontology (Figure 8).

Prior to any actual exchange of resources between trading partners, the business transaction “can be considered to be constructed from a set of fundamental activities (ISO, 37). Tasks

FIGURE 7
Progressive Societal Information Clusters



undertaken by the trading partners accomplish the various phases, and the associated outcomes represent a significant set of information that could be considered relevant to any stakeholder. The phases include:

Planning (L1)

The planning phase includes those activities that support the buyer and seller deciding what actions are required to acquire (or sell) a resource. In this phase, buyers and sellers collaborate to specify the types of resources to exchange. The completing of this planning phase results in types of resources becoming candidates for future exchanges.

Identification and Negotiation (L2)

The completion of the planning phase creates a situation in which the buyer and seller decide whether they should collaborate further regarding the planned resource acquisition. During this "Identification" phase, information is exchanged concerning resource specifics that meet the type specification of the planning phase. Information exchanged during this phase includes specific characteristics such as price and availability—"Do you have the model car in stock and at the required price?" This search for information represents a significant move forward in the business transaction. Stakeholders could be interested in the way in which trading partners interact and how exchange of information is supported. In an e-commerce setting, this might be viewed as actually visiting the website to gain further information after an initial search for "Small SUVs." The initial search indicates that there is a "Plan" to acquire the resource, where selecting a particular site moves to the phase where there is an attempt to identify possible trading partners from all those that

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were returned in the initial search. The completion of this phase can involve abandoning certain possible partners or websites and/or moving forward with others.

Once a group of possible partners has been identified, formal exchange activities are undertaken. During this "Negotiation" phase, information concerning the specifics of any actual exchange is shared. In this Negotiation phase, the information exchange is designed to come to a mutually shared and understood definition of all aspects of the business transaction. The information exchanged during the Identification phase is of the form "Do you have ..." or "I am looking for ...," whereas the information exchanged in the Negotiation phase is of the form "If you have ... at ... price, I will buy it." The termination of the Negotiation phase will either conclude either in a rejection of the offer, in which case the business transaction is abandoned, or an acceptance of the terms and a resulting continuance of the business transaction. Stakeholders should have particular interest in information about the activities of this Negotiation phase. Both those negotiations that end in failure and those that are successful are of interest. Failed negotiations serve as an indication of the firm's inability to compete in a particular market, whereas successful negotiations indicate that sales should be anticipated. The results of the Negotiation phase also serve as a template for future actual exchanges.

Actualization (L3, L4, L6, and L7)

For those transactions that were successful in the Negotiation phase, the resources specified must be delivered or received under the terms of the agreement completed during negotiation. The "Actualization" phase includes all those activities necessary to complete the exchange of the specified resources. It is possible to come to a conclusion about the appropriateness of the actual exchange by referring to the terms agreed upon during the Negotiation phase. The Actualization phase includes an exchange of resources per the Negotiation. It is the results of these activities that are summarized on financial statements—information from the previous phases does not find its way into traditional reports to stakeholders. For instance, when a seller actually delivers a resource per the terms of the negotiation, it is appropriate to indicate this by increasing the sales figure on a financial statement. When either of the parties to the exchange have not executed all the activities related to the negotiation, it is also appropriate to indicate this on traditional financial statements. If one party delivers the resource and the other has not completed its immediate cash payment requirements, entries such as accounts receivable are appropriate. For stakeholders, this is the only set of information available to describe a business transaction that has moved through a number of prior phases.

The last phase for a business transaction includes all those activities that are to be conducted after the actual exchange per the negotiated phase.

Consequent Events (Post-Actualization) (L5)

After Actualization, there is the possibility that additional activities could be required. Examples of these "Post-Actualization" activities (L5) include warranty work or service. While traditional business measurement focuses on the current observed events, post-sale events such as customer service present an important view of business that also might be very revealing for issues such as product quality and customer opinion. These variables also present some feed-forward effects on sales, returns, and business planning. Clearly, there are accounting issues that might arise if the sale of a resource requires subsequent post-actualization activities.

A panoramic view of all these phases, analogous to Figure 6, but not more based on the REA frame, is in Figure 8. This view of the world raises a series of measurement issues, such as:

- How frequently should external reporting be performed (yearly, quarterly, hourly, concurrently)?

FIGURE 8
Phases within Business Processes from ISO 15944

BT Phase	Example Business Event
Planning	Seller publishes <i>Catalog</i>
	Buyer sends <i>Catalog Request</i> to Seller
	Seller sends <i>Catalog</i> to <i>Prospective Buyer</i>
Identification	Buyer sends <i>Availability and Price Request</i> to Seller
	Seller returns <i>Availability and Price Result</i> to Buyer
Negotiation	Seller sends <i>Order Request</i> to Buyer
	Buyer sends <i>Offer</i> to Seller
	Seller sends <i>Counter Offer</i> to Buyer
	Buyer sends an <i>Order Acceptance</i> to Seller for parts. (Alternatively, a <i>Non Acceptance</i> would suspend or abandon the Business Transaction)
Actualization	Seller sends an <i>Advance Shipping Notice</i> when goods are prepared for shipping
	Buyer sends <i>Receiving Report</i> to Seller when inspected goods are accepted
	Seller sends an <i>Invoice</i> to Buyer after parts are shipped
	Buyer sends <i>Remittance Advice</i> to Seller with information about payment of the invoice
Post-Actualization	Buyer sends <i>Warranty Invocation</i> to Seller

Source: ISO15944 - 43Feb2007 page 42

- How far into the early stages of business should the reporting system go?
- Have the costs and benefits of reporting changed enough so that it is worthwhile and feasible to create different forms of external reporting, say, for: (1) naïve investors, (2) sophisticated investors, (3) bankers, (4) liquidators, or (5) supply chain participants?
- Can analytical methods such as continuity equations (Kogan et al. 2011) be developed to better link the ERS and NRS, so that deviations such as round-tripping, fictitious employees, and channel stuffing are detected and, therefore, do not occur?
- What is the basic entity of measurement of business? The business organization? The process? Other?

This improved linkage among now-measurable items, to the point of specific identification (e.g., RFID) elements, inevitably changes the scenario of internal business measurement. The emergence of the XML standard and the consequential interoperability of processes that allow different companies and outsources to easily exchange data also create new economics for data exchange, as well as new ways of doing so.

THE POINT MEASUREMENT OF EACH DATUM

While for current users of financial data, a schema such as the one being presented may seem cumbersome and unrealistic, advancements in information technology and the information needs of business may significantly ease methods of measurement and reporting. For example, a tagged datum schema that uses an XML derivative language, such as XBRL,⁶ may contain core data enriched by a multiplicity of parameters, creating a more complex and representative schemata for business measurement.

The tags can represent several decision-relevant elements, such as the measure that maps the NRS with the ERS; the point in time when the measure was valid, the context within which the measure was valid, and the reliability of the measure.

As illustrations, the following "point measurements" (PM 1 and PM 2) depict two sets of information collected on a certain business variable, each with two different representations. These reporting schemas represent a realization of the fact that our current set of accounting rules are simply the reporting aggregations of the finer information set that is located in corporate systems that are being rendered in potentially different formats, levels of aggregation, and business assumptions for multiple decision purposes. Although in the past, accounting standards were the predominant issue, today they are less relevant for comparability measurement due to the flexibility of reporting systems, and could be selectively interpreted to support decisions from different stakeholder groups.

PM 1: Measurement of a business variable = $f(\text{activity level; time; decisions that it is designed to support; level of precision; conditioning future events; probability characteristics})$.

For example:

*Inventory = $f(\$2,000,000; \text{November 15 2011; liquidation for bankruptcy; } \pm 10^{**4}; \text{none; normal distribution estimate})$*

or, representing the same inventory value:

*Inventory = $f(4,000,000 \text{ yen; November 15 2011; replacement value; } \pm 10^{**3}; \text{none; normal distribution estimate})$*

While some of these parameters may be less relevant than others for certain decisions (labeled as none or NA), the framework may have value in representing the measurement of business.

Furthermore, the model can be expanded with the inclusion of a likelihood of occurrence factor to deal with contracts in process, legal contingencies, sales leads, etc. Examples of this follow:

PM 2: Measurement of business variable = $f(\text{activity level; time; what decision does it support; level of precision; conditioning future events; probability characteristics, likelihood of occurrence})$.

For example:

*Contract with the government = $f(2,000,000; \text{November 15 2011-2013; future sales projection; } 10^{**4}; \text{winning the RFP; normal distribution estimate; 30\%})$*

or:

⁶ See: <http://www.xbrl.org>

FIGURE 9
Measuring the Corporate Business Cycle

Environmental Conditionants	Business Plans	Lead Actions	Business Events	Consequent Events
E-commerce sales are growing 25% AA	Create a e-activity aimed at young customers	Create a web-site		
		Create payment mechanisms		
		Contract with FedEx for logistics		
		Stock inventory	Sales	Post sale care
				Warranty support
				Returns
				Customer feedback

*Cash from Lawsuit = f(4,000,000; Mid 2008; cash projections; 10*3 judge setting damages; normal distribution estimate; 80%).*

Taking this model further will allow for the creation of business representation models at the different levels, such as represented in Figure 9.

In the modern real-time economy, value chains and processes are not what they used to be:

- Previously, the traditional internal value chain was typically part of the same company and in the same physical location. Nowadays, the modern value chain has many outsourced processes, often being performed in different countries, in particular, in the information portion of the value chain. Consequently, some out-of-the-system measurements must be performed.
- The traditional production chain contains inventories of component parts being used by manufacturing. Just-in-time manufacturing has changed substantially the schema of ownership, controls, and reporting. The fact that an ABC company has component parts in its facilities that it does not legally own creates complex relationships that may require consolidation along the value chain, rather than across subsidiaries.
- Currently, contractual relationships with outsourcers carry heavy termination penalties, high initial investments, and an entire set of new obligations that the traditional measurement system simply cannot capture.

Measuring the business entity in its earlier stages is inevitable if useful representations are to be obtained. In order to further evaluate the needs of enterprise measurement, we must consider such possible measurement parameters.

THE LEVEL OF DESIRED CONTINGENCY MEASUREMENT

The decision context ultimately determines the desirable information structure. For example, creditors have considerable interest in the ongoing health of the company, and in the case of a high probability of failure, interest in the liquidation value of assets.

On the other hand, banks and insurance companies have substantial interest in the progress and features in ongoing management in order to be able to intercede or change conditions if certain contingencies arise. A bank may be willing to change loan conditions if this involvement increases the probability of repayment. Insurance companies that issued swaps on company papers have a continuing interest in the probability of default and in the possible actions to avoid this condition.

A series of other contingencies, many of which are not captured in current reporting standards such as GAAP, are important. Some of these issues are discussed next.

Contractual and Non-Contractual Obligations

Extending the reporting model to the early levels (L0, L1, L2, and L3) brings out what is probably the most important limitation of the conventional BRMM (business reporting measurement model). Most contractual obligations are not recognized. For example:

- Sales contracts/long-term supply contracts
- Employment contracts, golden parachutes, severance payments
- IP acquisition costs
- Environmental obligations
- Contractual contingency requirements

The quantification and disclosure of these contracts are highly problematic. Descriptive notes may be used to provide contractual information, subject to materiality and relevance filtering. Information technology allows for hierarchical organization of documents and extraction of key facts. Similar documents (e.g., large sales contracts) may be aggregated, but not disclosed in detail to mitigate competitive disadvantage. Standards can be developed encompassing document description using meta data and hyperlinks/summarization provided at this level.

Measured and Disclosed Obligations

The gap between complex contracts and their numerical value determination is immense. Complex contracts may have hundreds of pages of description and only one sentence ultimately negating or changing its economic schema. AIG had thousands of contracts and obligations, but its demise, even with many very profitable units, was based on a series of simple clauses that determined a substantial increase on needed reserves in the unlikely event of losing its high credit ratings.

Obligations of all types (formal and implicit, probable, and less probable) may or may not be disclosed and measured. Due to this asymmetry of information disclosure and its utilization, it is impossible to anticipate the modes of information usage. Consequently, the links between provided information and its subsequent interpretation are increasingly more tenuous with a decrease in probability of events. Traditional accounting measurement has erred on the conservative side, allowing its professional audit bias, and only recording the verifiable measurements. An entire new generation of analytic measurements and information clusters is redefining what is verifiable and the desirability of information inclusion into the formal reporting system. To further complicate this issue, measurements are not static in nature, even at a distinct point in time. Their disclosure may change the *a priori* measurement of an event.



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For example, the U.S., FASB, the accounting profession, and the legal profession have been in a tug of war about the disclosure of legal contingencies. In particular, they are concerned about the feed-forward effect of the measurements of potential liability. This is one of those cases where the measurement may have self-fulfilling consequences: the probabilistic estimate of damages may bias the outcome of a trial.

The current set of disclosures on legal contingencies is not tremendously valuable, because the user gets little information concerning likely estimates and probability distributions. This deliberate obfuscation effect serves to negate the feed-forward effect discussed above.

Due to the possible information asymmetry and potential feed-forward effect, a generic rule of measurement and disclosure ensues:

If the interpretation of the measurement is too complex or disruptive, do not create aggregate measures but provide pure data disclosures and leave their measurement and interpretations to the users.

For example, many modern financial organizations hold a wide variety of credit default swaps; some of them publicly traded, others by private arrangement tailored to a particular issue. Although their face values are in the trillions of dollars, they are not explicitly recognized in financial statements. If they are deemed too difficult to measure, they should be standardized and disclosed through meta descriptions as described above.

Obligations that are Not Disclosed

Organizations often have obligations that are not disclosed to users of financial information, such as:

- Obligations with golden parachutes and future pension obligations with executives
- Fines and other legal liabilities incurred, but not yet due
- Obligations with suppliers and clients relative to business continuity

Implicit Obligations

Furthermore, two different types of obligations that may not fall under a traditional contractual view include:

- Community contributions—there is an implicit obligation of support to community-related activities on an ongoing basis, e.g., Little League, PTA, etc.
- Corporate social responsibility (CSR)—although measurement of CSR was not required in most countries years ago, it is becoming increasingly regulated in current years. This evolution was a result of corporate stakeholders requiring an increase in CSR disclosure. The value placed on this information is evidenced by its effect on trading value of companies reporting on this topic, customer loyalty, etc. (Fenn 2011; Smith et al. 2010; Kulabako 2010; Moneva and Ortas 2010).

Obligations at the Value Chain not in the Corporate Structure

There are many contractual and non-contractual issues that do not finalize in the corporate structure. Among these issues, we find obligations around the value chain, in outsourcing and offshoring situations, and with clients and suppliers. These relationships are different than sales contracts in that there is substantial partnership and some comingling of assets.

The Internet has allowed for a very large degree of integration among the business partners in the value chain. While often these obligations are not contractual, they are practical, as supply chain

relationships must be preserved and moral. The classic example was the write-down by Cisco of substantial inventory overvaluation that was attributed to obligations to their suppliers.

Future Estimates

A final type of information that does not fit well in any other category is the inclusion of future estimates in business measurements. Ultimately, business reporting is not aimed at the past, but rather as guidance for future decisions.

Future estimates (forecasts) do not fit well with the generic category of contingencies, but similar considerations may apply. Two important attributes of future estimates are: source (management, third-party analysts, others) and probability (some type of reliability scale).

Point of measurement 2 (PM 2) may be applied also to forecasts as PM 3:

PM 3: Measurement of forecasted business variable = f(estimated activity level; time; decision(s) that it is designed to support; level of precision; conditioning future events; probability characteristics, likelihood of occurrence, issuer of forecast, accuracy of past forecasts).

CONCLUSIONS

This paper used measurement theory to attempt to draw some insight into corporate reporting. Initially, it created a context for the analysis examining the ERS versus the NRS, including: time dependencies, usage dependencies, level or precision, futurity, and probability of the event. Next, it applied this discussion to three layers of entity measurement, proposing a view of business as a value chain and schemata for point measurements of business variables. Finally, the areas of contingencies and future estimates were examined, and a third point measurement schema was proposed to satisfy specific information characteristics of future estimates. These point measurement schemata may serve to create a conceptual basis for an expanded view of XBRL and its tagging as a wide-scope implementation of business measurement.

There are many limitations and weaknesses in the proposed schema, as (1) it lacks specificity or actual implementations, (2) it creates the potential for lack of comparability among reports, (3) it changes dramatically the current approach, making transition very difficult, and most of all, (4) it is normative and speculative.

Business needs are evolving and current measurement solutions must do likewise. While, historically, societal mechanisms have been adequate for finding measurement solutions, this is not true of recent decades. The gap between user needs and reporting solutions has widened and is growing. The criticisms listed above, most of which have been discussed in other venues, clearly add to the conclusion that the current business measurement model is inadequate and, given the rapid changes in needs and technology, this model is becoming progressively less useful.

The standard business-setting process has failed to evolve with reporting technology and the evolution of the business process. Consequently, we observe the ever-widening gap between corporate financial measurement and business reporting. Furthermore, it seems that societal mechanisms are not able to cope with this change. Hence, this new BRMM may be like a disruptive technology" (Christensen 2003).

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