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A Comparative Study of ICT Value Measurement Models

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***Abstract* – The value of ICT to service industry in both context and perspective could be used as a basis for exploring its service systems. Besides, ICT value measurement helps to uncover the contribution of ICT to the tripod goal of service organisation(s): profitability, staff productivity and customer satisfaction. However, how to measure the value of ICT which are often times intangible, is not only strange to services science experts and managers of service organisation but also confront them with the problem of choice of the appropriateness of existing ICT value measurement tool(s) to a service organisation. This paper attempts to be a one stop shop to services science experts and managers of service organisation by identifying and explicating among the several intangible value measurement tools those that are particularly suited to ICT value measurement and exposed their features, strengths and weaknesses. This will help in uncovering the contribution of ICT to service organisations.**

***Keywords* – Services Science, ICT, Value Measurement Tools, Service Organisation**

I. INTRODUCTION

The expansion of the services sector, globalization, deregulation, and the emergence of new information technologies have brought to the fore the issue of how ICT value is created, disseminated, retained and used to obtain service returns. Measuring this value will help improve management control over ICT driven organisations. The idea is founded on one of the most quoted management slogans; "what is not measured, cannot be effectively managed"[1]. In particular, the value of ICT to service industry in both context and perspective could be used as a basis for exploring its services system, [2]. Very importantly, ICT value measurement helps to uncover the contribution of ICT to the tripod goal of service organisation(s): profitability, staff productivity and customer satisfaction. This value could be tangible or intangible [3].

Tangible value are those that have a physical substance capable of being appraised at an actual or approximate value while intangible value lacks physical substance which represents the knowledge and skill sets of the organization. Intangible value can be seen as the vehicle for integrating knowledge into a services department or processes in an organization. [4] sees intangible value as a static concept (e.g. resources – intellectual capital; innovation, employees' capabilities and competencies, and customer's satisfaction) and also as a dynamic concept (e.g. growth and renewal, efficiency and stability). Measuring tangible value (like profit) is an established practice in management and finance but measuring intangible value though strange is critical to the survival and competitiveness of modern day service industry. Several intangible value measurement models abound (see figure1) and are usually scattered across different literatures. This often get services science experts and managers of service organisation confused when it comes to which of the model(s) to employ; for it is not only irrational but it is also impossible in a given context or organisation, to use all the existing value measurement models. In particular, knowing which of these models or tools is suited for intangible ICT value measurement is another issue. Consequently, this paper identified and explicates among the several intangible value measurement tools those that are particularly suited to ICT value measurement; exposed their features, strengths and weaknesses, so that services science researchers, consultants and managers may have a single document that can guide them on which measurement tool(s) is appropriate for intangible ICT value measurement in a given service industry.

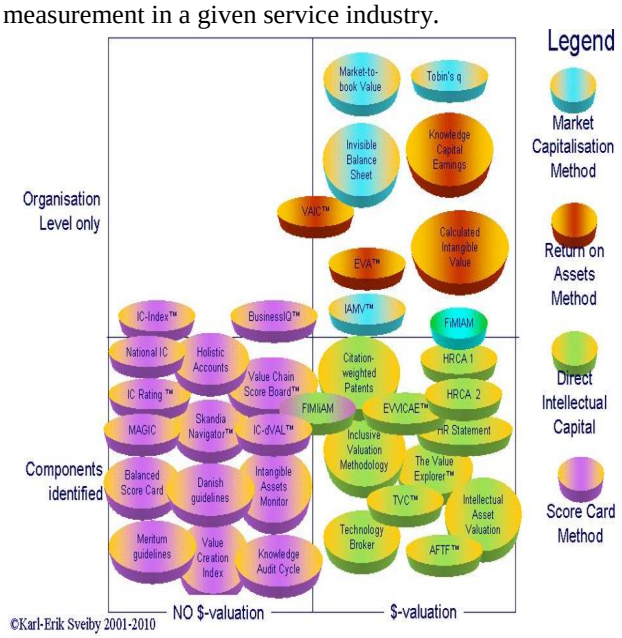

Fig.1. Intangible Value Measurement Models [3]

II. APPROACHES FOR MEASURING VALUE OF ICT

The suggested ICT value measurement models fall into four categories of measurement approaches. The categories are an extension of the classifications suggested by [5]:

A. Direct Intellectual Capital methods (DIC)

Estimate the monetary value of intangible value by identifying its various components. Once these components are identified, they can be directly evaluated, either individually or as an aggregated coefficient.

B. Market Capitalization Methods (MCM)

Calculate the difference between an organization market capitalization and its stockholders' equity as the value of its intellectual capital or intangible value.

C. Return on Assets methods (ROA)

Average pre-tax earnings of an organization for a period of time are divided by the average tangible value of the said organization. The result is an organization ROA that is then compared with its industry average. The difference is multiplied by the company's average tangible assets value to calculate average annual earnings from the Intangibles. Dividing the above-average earnings by the company's average cost of capital or an interest rate, one can derive an estimate of the company's intangible values or intellectual capital.

D. Scorecard Methods (SC)

The various components of intangible values or intellectual capital are identified and indicators and indices are generated and reported in scorecards or as graphs. SC methods are similar to DIS methods, except that no estimate is made of the monetary value of the Intangible value. A composite index may or may not be produced.

These methods offer different advantages. Generally, they can be used for comparisons between organization within the same ICT based industry and they are good for illustrating the financial value of Intangible assets. The methods can create a more comprehensive picture of an organisation's ICT health than financial metrics and can be easily applied at any level of an organisation. Those that do not need to measure in financial terms, are very useful for non-profit organisations, internal departments and public sector organisations. Their disadvantage is that when translating everything into monetary terms they can be superficial. The ROA methods are very sensitive to interest rate and discounting rate assumptions. Some of them are of no use to non-profit organisations, internal departments and public sector organisations; this is particularly true of the MCM and DIC methods. Generally, their indicators are contextual and have to be customised for each organisation and each purpose, which makes comparisons very difficult. These approaches can generate oceans of data, which are sometimes hard to analyse and communicate.

III. MODELS FOR MEASURING ICT VALUE

There are several models for ICT Value measurement and notable among them are: Tobin's Q, Intangible Asset Monitor, Calculated Intangible Value, Value Added Intellectual Coefficient (VAIC), IC-Index, Technology Broker and Skandia Navigator.

Each of these models has some interesting characteristics; that help focus, not just on the components of value, but on trends, momentum, underlying factors, interactions and sensitivities to risk.

A. Technology Broker [6]

This example of DIC makes a practical contribution to Intellectual Capital (IC) measurement by offering three measurement models to help calculate the monetary value of IC as identified by the Technology Broker's IC audit. It defines IC as the combined amalgam of these four components: market assets, human-centred assets, intellectual property assets and infrastructure assets. It proposes that the value an organization place on its ICT is wholly dependent upon the goals of the organization and the state of the market as such, any valuation is organization-specific and limited in time [7].

Once an organization completes its IC Technology Broker audit, Brooking offers three methods to calculate the monetary value for the IC identified by the audit:

- The cost approach, which is based on assessment of replacement cost of the asset;
- The market approach, which uses market comparable entities to assess value; and
- The income approach, which assesses the income-producing capability of the asset.

[7] suggests that Brooking has created an IC audit that represents an intellectual asset for organizations. Moreover, Veltri (2009) active marketing of the instrument and its conceptual basis has served to help others identify, value, and leverage the IC in their organizations. There are also many similarities between the Technology Broker IC audit questions which are subjective in nature and Skandia's IC measures [8] which are objective.

The main weakness with this model is that there is a considerable leap that must be made from the qualitative results of the questionnaire to actual monetary values for these assets. Finally, the income-based model suffers from subjectivity of estimations and uncertainties inherent in the cash-flow model.

B. Tobin's Q [9]

This MCM approach is the ratio of the market value of a firm's assets (as measured by the market value of its outstanding stock and debt) to the replacement cost of the firm's assets. This measure of performance is not used as often as either rate of return or price-cost margins. If a firm is worth more than its value based on what it would cost to rebuild it, then excess profits are being earned from effective performance of a firm's IC. The ratio Tobin's q is calculated by dividing the market value of a company by the replacement_value of the book equity i.e. Tobin's q = (Equity Market Value + Liabilities Book Value)/ (Equity Book Value + Liabilities Book Value).

Another use for q is to determine the valuation of the whole market in ratio to the aggregate corporate assets. The formula for this is: q = Value of Stock Market/Corporate Net Worth.

C. Calculated Intangible Value [10]

This is an ROA model. Here, to calculate the value of ICT, the value of intellectual capital is considered to be the difference between the firm's stock market value and the company's book value. The method is based on the assumption that a company's premium earnings, i.e. the earnings greater than those of an average company within

the industry, result from the company's ICT. [11] gave a good example of the calculation.

It offers a quick, yet accurate way to calculate intangible value by gleaning all the information needed to determine intangible value from public resources. It is however not a reliable valuation of intangible value, unless one is working for the firm in question. Finding and determining the replacement costs for all assets is time consuming and herculean.

D. Value Added Intellectual Coefficient (VAIC) [12]

It also known as the Value Creation Efficiency Analysis. This is another ROA model based on an equation that measures how much and how efficiently intellectual capital and capital employed create value based on the relationship to three major components: capital employed, human capital and structural capital.

The VAIC is used as a measure to evaluate the efficiency of corporation:

Output = Net Premium;
Input = Operating expenses (excluding personal costs);
Value added = Output – Input;
HC = personnel cost (Salaries and wages), considered as an investment;
CA = Capital employed (both physical and financial capital);
SC = VA – HC;
HCE = VA/HC (Human Capital Efficiency);
CEE = VA/CA (Innovation/Capital Employed Efficiency) and
SCE = SC/VA (Organizational Capital Efficiency).

Human capital is the collective capability of a service organisation to extract the optimum solutions from employee knowledge, and is a direct consequence of the sum of workforce expertise, knowledge and attitude. The three items used to assess human capital are based on the discussions of human capital by [6,13] including discussions of 'leadership and management ability', 'training and development of human resources', 'workforce attitudes', and 'employee knowledge and skills'.

Innovation capital is defined as the ability to build on previous knowledge and generate new knowledge. Innovation capital includes the ability of a service organisation to develop new services, as well as any creative ideas. The two items used to measure innovation capital included the tacit item 'Innovation and technological ability' [14] and the explicit item 'Intellectual property' [8].

Organizational capital belongs to the company, and is the actual environment established by a service organisation to manage and generate its knowledge effectively. Organizational capital includes information system, operation process and organization culture. The four items assessing organizational capital draw on the work of [10]. [15] emphasized an internal institutionalized knowledge and codified experience stored in organizational memory devices, including operational process, internal organization structure and administrative system, Information system, and Organization culture.

As an index, the higher the VAIC the better will be the efficiency and value creation ability of a service organisation. VAIC is calculated by summing the three efficiency items (CEE + HCE + SCE). This aggregated indicator allows us to understand the overall ICT efficiency of a company and indicates its intellectual ability.

Apart from encompassing the concept of value added and enabling one to decipher the value added efficiency of a company, several other major reasons underscore the use of the VAIC methodology.

First, VAIC provides a standardized and consistent basis of measure thereby, better enabling the effective conduct of an international comparative analysis using a large sample size across various industrial sectors. Alternative IC measures are limited in that they: (a) utilize information associated with a select group of company; (b) involve unique financial and non-financial indicators that can be readily combined into a single comprehensive measure; and/or (c) are customized to fit the profile of individual company.

Secondly, all data used in the VAIC calculation is based on audited information; therefore, calculations can be considered objective and verifiable. Additionally, concerns have been raised about difficulties in verifying information used in calculating indicators comprising other ICT measures.

Also, VAIC is a straightforward technique that enhances cognitive understanding and enables ease of calculation by various internal and external stakeholders. Ease of calculation is a feature that has enhanced the universal acceptance of many traditional measures of corporate performance (such as ROA, market-to-book value). Alternative ICT measures are limited as they can only be calculated by internal parties or rely upon sophisticated models, analysis and principals. Finally, the VAIC methodology is utilized in more and more studies as it is receiving increasing research attention.

E. IC-Index [8]

This score card model Consolidates all individual indicators representing intellectual properties and components into a single index. Changes in the index are then related to changes in the firm's market valuation. Since Skandia's adoption, the logic of an IC-Index has been endorsed and implemented by many other practitioners.

The IC-Index has several distinct features which include:

- It is an idiosyncratic measure;
- It focuses on the monitoring of the dynamics of IC;
- It is capable of taking into account performance from prior periods; and
- It is a self-correcting index in that if performance of the IC-Index does not reflect change of the market value of the company, then the choice of capital forms, weights, and/or indicators is flawed.

The IC-Index is context specific because it permits boundaries to be placed around the measurement of intellectual capital. While the concept of IC can include all intangible resources and their flows (i.e., any factor

that contributes to the value generating process that do not come from a company's physical or monetary assets), [8] support restricting the IC conceptual definition used to create an IC-Index to those company intangible processes that are more or less under the control of the company itself. [13] propose that the specific measurement of company IC forms, weightings, and indicators can be decided by knowing the company's strategy, characteristics of the particular business of the company, and its day-to-day operations.

[8] suggest that this process model can help create an ICT measurement system and especially the selection of the right indicators. To do this, they refer to the "value scheme" that describes the sources of company value coming from intellectual capital. They believe that once a company has a clear idea about its identity and strategy, it should use its long-term goals to identify two sets of variables: one set comprising its value-creating path (i.e., those IC categories that really drive company value creation); and the other set that can act as performance measurements. This second set is made up of key success factors (KSF) that can describe more than one company, and indicators which reflect a company's characteristics more closely. Information from the two steps is then to be joined leading to the creation of an IC system. Unfortunately, although the authors state that information from the two sets should be joined together to create the IC measurement system, they did not explain whether each category has its own measurement, and how such measures duplicate or offer unique variance from that contributed by the second set of KSF and indicators.

An IC-Index is very much context specific and is therefore limited in use across companies. Definitions, strategic prioritizing, choice of indicators, etc. all make comparisons of any absolute IC-Index summary value calculated for different companies or over time by one company meaningless. In addition, because only proxy measures are taken of IC stock, all metrics are dimensionless, ordinal numbers [13].

An IC-Index does depend on value judgments, in the choice of weights, indicators, and even the assumption that IC is present and important in company operations. Although this charge of subjectivity can also be made of certain traditional accounting methods and assumptions [13] argue that at least IC measurement and especially a consolidated measure such as the IC-Index, makes a larger part of the organization visible and open to valuation.

F. Skandia Navigator [14]

Skandia is considered the first large company to have made a truly coherent effort at measuring ICT value [8]. According to Skandia's model, another score card model, the hidden factors of human and structural capital when added together comprise intellectual capital.

Human Capital is defined as the combined knowledge, skill, innovativeness, and ability of the company's individual employees to meet the task at hand. It also includes the company's values, culture, and philosophy. Human capital cannot be owned by the company.

Structural Capital is the hardware, software, databases, organizational structure, patents, trademarks, and everything else of organizational capability that supports those employees' productivity - in other words, everything that gets left behind at the office when employees go home. Unlike human capital, structural capital can be owned and thereby traded.

Intellectual Capital equals the sum of human and structural capital.

The Skandia Intellectual capital report uses up to 91 new IC metrics plus 73 traditional metrics to measure the five areas of focus: finance, customer, process, renewal and development, and human which constitute the Navigator model. [14] acknowledged that various indices may be redundant or of varying importance.

Most researchers agree that Skandia's considerable efforts to create a taxonomy to measure a company's intangible value has emboldened others to look beyond traditional assumptions of what creates value for organizations. Skandia's model is particularly impressive in recognizing the role of customer capital in creating value for an organization and how the very nature of customer relationships has changed. Skandia also provides a broad coverage of organizational structural and process factors with its focus on process, and renewal and development contributions to organizational value that has not been attempted before.

[16] points out that Skandia assigns no monetary value to its IC, but uses proxy measures of IC to track trends in the assumed value added. Moreover, when measuring its intangible value, it offers only a snapshot in time and cannot represent dynamic flows of an organization. Finally, [17] noted that Skandia's inclusion of Structural Capital variables that include PCs, say, as creators of true value can be criticized because it presumes that employees showing up for work and sitting in front of their computers end up investing knowledge into that computer that translates into the company's competitive advantage. For that to occur, however, data given to the employee must be transformed into information, and that information converted into added-value knowledge which is rarely automatic.

IV. CONCLUSION

We have identified and explicated six ICT value measurement tools that are particularly suited to measuring the value of ICT in a service organisation. This was necessitated by the difficulty in making a choice on the appropriateness of value measurement tools for ICT value measurement by services science experts and managers of service organisations.

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