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Seismic Measurement of Management Accounting Innovations: Using the Scale of Innovation Intensity

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Abstract

The purpose of this paper is to determine the intensity of the contribution of Balanced Scorecard (BSC), Activity Based Costing (ABC), and Lean Accounting (LA) have had in the academic literature. An approach that is derived from Seismic measurement of earthquakes is adopted to produce what has been labelled the Scale of Innovation Intensity model. The three innovations were found to have measures of intensity that fall within the medium level of intensity. The findings support the arguments that the three management accounting innovations have had an influence on the direction of management accounting. This paper also provides a general overview of the application of the scale of innovation intensity and its potential for future research.

Keywords: Activity Based Costing; Balanced Scorecard; Innovation Intensity; Lean Accounting; Management Accounting Innovations

1. Introduction

> *"Space, the final frontier. These are the voyages of the Starship Enterprise.*
> *Its continuing mission to explore strange new worlds, to seek out new life and new civilization, to boldly go where no one has gone before."*
>
> *(G. Roddenberry, Star Trek)*

It seems appropriate to open with this famous saying given that at the dawn of the 21st century humanity is planning to send a mission to Mars, and management accounting is facing new frontiers. Of course, this is also an auspicious occasion with the first edition, or to use a NASA term, the launch of the renamed journal published by the Institute of Certified Management Accountants (ICMA), which heralds the change of name from the Journal of Applied Management Accounting Research to

Management Accounting Frontiers. With apologies to Genne Rodenberry a revised version of this opening statement could be:

> "*Management Accounting, the final frontier. These are the research expeditions of the Journal. Its continuing mission to explore strange new developments, to seek out new technologies and new organizations, to boldly go where no accountant has gone before.*"

Not possessing a crystal ball makes it very difficult to see in to the future or comment on the nature of challenges that may face the management accounting discipline predictions cannot be made with any certainty. So rather than attempt to make any predictions it would seem better to reflect on where management accounting has come from and more importantly what changes have been achieved.

Since the criticisms levelled at what has been referred to as traditional management accounting by Johnson and Kaplan (1987) there has been a wave of innovations that have washed over the management accounting discipline and impacted on processes and techniques (Modell, 2009). There may well be other innovations that have occurred in the management accounting discipline, however, for providing a simplistic exploration the focus of this paper is restricted to the three arguably most notable innovations. These are, the Balanced Scorecard (BSC), Activity Based Costing (ABC), and Lean Accounting. The extent to which these innovations have contributed to the knowledge base of management accounting, could arguably be viewed in terms of the extent to which they have been recognised in the management accounting literature and subjected to research over time.

It is not the intention in this paper to go into any deep analysis but rather to consider the contribution to management accounting that each of these may have made. However, what follows is a brief overview of the characteristics that distinguish the three selected innovations from the traditional management accounting perspectives and approaches. To start, the Balanced Scorecard (BSC), is a measurement system for monitoring the balance between the drivers and outcomes (lead and lag indicators) that track an organisation's performance against strategic goals (Kaplan & Norton, 1992). A balanced scorecard focuses on four different perspectives financial, internal business processes, learning and growth, and customer as the means to measure organisational strategic performance. The four characteristics of the balanced scorecard according to Kaplan and Norton (2004) are (1) it is a top down reflection of the overall strategy; (2) it is focused on the future not the past; (3) it

integrates external with internal measures; (4) it focuses only on the most critical measures of strategic success.

Activity Based Costing (ABC), differs from the above models in that it is an alternative method for allocation of costs for products or services (Cooper, 1988). It is more concerned with providing an economic model of production related activities (Kaplan, 1992). It focuses on identifying and then using the causal cost drivers to assign activity costs to products, services and even customers (Cooper, 1988). It is a method for determining on the value-added and non value-added activities, the costs associated with those activities and ultimately the drivers of the activities (Ittner, Lanen & Larcker, 2002).

Lean Accounting, is aligned with the notion of restructuring manufacturing processes to eliminate waste or anything that does not add value to a product (Ruiz-de-Arbulo-Lopez, Fortuny-Santos & Cuatrecasas-Arbos, 2013). The Lean approach is more of a philosophical ideal that when translated to the management accounting perspective means there is only one single cost collector which is referred to as the value stream. In this approach, a product unit cost is not considered important for management decision making instead Lean philosophy focuses on gaining competitive advantage by the reduction of waste throughout the life cycle of a product (Hu, Mason, Williams & Found, 2015). As such, it differs from the traditional view that cost advantages are derived from economies of scale.

This paper seeks to explore the extent of the growth in recognition and arguably acceptance through recognition of these innovations by the means of measuring the intensity of their acceptance. In this situation the number of research papers published over time is used as a proxy for intensity since the outcomes of management accounting are recognised internally by organisations and the only publicly available data indicative of intensity is the published literature.

2. Innovation Intensity Measurement

The innovation process itself has been vicariously described as involving radical, incremental, new, evolutionary improvements (Garcia & Calantone, 2002). Unfortunately, there is a lack of consistency in defining the term innovation and this has carried through into research that are in turn inconsistent in the constructs or variables that were used (Chandy & Tellis, 2000; Green, Gavin & Aiman-Smith, 1995; Henderson

& Clark, 1990; Meyers & Tucker, 1989). The literature review by Garcia and Calantone (2002) identified a basic definition by the OECD (1991) which appeared to capture the consensus view:

> "*Innovation is an iterative process initiated by the perception of a new market and/or service opportunity for a technology-based invention which leads to development, production, and marketing tasks striving for the commercial success of the invention."*

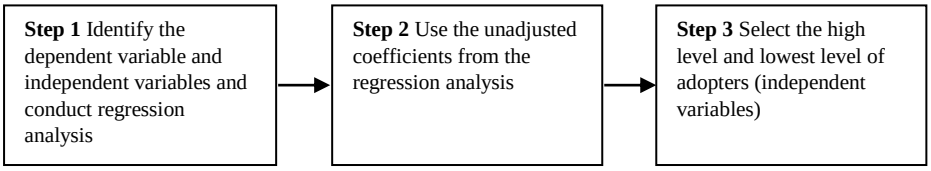
Innovations are an essential factor in achieving economic and social change within an individual firm or for that matter an entire industry or sector (Pavitt, 1984). From the economic perspective the hedonic approach to the measurement of technological change is based simply on the assumption that the utility of a product or service lies in its essential attributes or quality characteristics which implies a positive relationship between market price of a good or service and its quality or usefulness (Lancaster, 1966; Saviotti, 1985). For example, in the case of an automobile the characteristics would be, size, power, comfort, safety and fuel economy (Court, 1939).

Coccia (2005a) examined the history and patterns of technological innovations over the second half of the twentieth century and identified a distinct field of investigation referred to as technometrics had evolved from a combination of disciplines, particularly econometrics, engineering and applied mathematics. From the numerous typologies related to innovation in the economics literature Coccia (2005b) synthesised the typologies to formulate a metataxonomy that subsumed the other, less comprehensive taxonomies. He proposed that the intensity of technological change could be measured by an indicator, called magnitude, which was based on the impact of technological innovations on the economic system to which they aligned. This approach is similar in nature to the seismology scale of Mercalli and Richter used to measure the intensity of earthquakes through the magnitude of energy recorded (Coccia, 2005b). The analogy with that of a seismic scale, even a simplified form, is arguably justifiable because as the intensity of an innovation increases so too do the effects that it has on the economic system to which it is aligned or in the case of management accounting the discipline area in which it resides.

According to Coccia (2005b) the underlying principle is that intensity can be measured by comparing the objects or subjects affected by an innovation to the changes in the economic environment. The model

developed by Coccia (2005b) consisted of three steps which, for the purpose of this paper, are presented in a simplified version in Figure 1.

Figure 1. Steps to measure intensity of technological change



Source: Coccia (2005b, p.128)

Coccia (2005b) developed a metric to categorise the seismic value of the outcome of the formula referred to as the scale of innovation intensity. The scale employs integral calculus to derive the innovation intensity (τ) which is based on the area underlying the function $zw=f(a)$. In the study the model was applied to evaluate a number of innovations, such as, agricultural mechanisation and its impact on the productivity per acre, and catalytic converts on motor vehicles and its impact on the level of SO_2 pollution. A simplified version of the scale is presented in Table 1.

Table 1. Scale of Innovation Intensity

Level Category	***MAGINCH =*** τ	***Examples***
Low	[0;4.5]	*Catalytic converter*
Medium	[4.5;7.9]	*Agricultural mechanisation*
High	[7.9; +∞]	

Source: Coccia (2005b, p.136)

3. Research Method

To source relevant literature the business database ProQuest was selected and searched, using the key search terms: "Balanced Scorecard", "Activity Based Costing", "Lean Accounting", and as the dependent variable surrogate measurement “Management Accounting”. Each of

these terms whilst addressed individually provide a consistent approach for determining the extent to which they have become embedded in the as research literature as well as the growth over time. The search was restricted to peer-reviewed journal publications to provide confirmation that such papers could be considered as having been subjected to a degree of rigour in the analysis of their content.

Regression analysis was conducted on each innovation against the number of management accounting articles and then an integral calculus formula was used to produce a measure of intensity.

4. Findings

For the purpose of analysis and indeed to provide a point for comparison the number of publications is subdivided into ten-year time series. Starting with 1980 to 1989 and then moving forward until reaching the 2010 period which does not extend for a full ten-year series. The number of publications which have been identified as falling within the ten-year series are presented in Tables 2, 3 and 4.

Table 2. Number of Publications in Peer-reviewed Scholarly Journals 1980-2017

	Balanced Scorecard (BSC)	***Activity Based Costing (ABC)***	***Lean Accounting (LA)***	***Management Accounting (MA)***
1980-1989	0	0	0	78
1990-1999	411	577	0	1,720
2000-2009	3,380	1,144	20	4,122
2010-2017	3,972	1,030	70	5,905
Total	**7,763**	**2,751**	**90**	**11,825**

Table 3. Percentage Growth of Publications within each Innovation

	Balanced Scorecard (BSC)	**Activity Based Costing (ABC)**	**Lean Accounting (LA)**	**Management Accounting (MA)**
1980-1989	0.00%	0.00%	0.00%	0.66%
1990-1999	5.29%	20.97%	0.00%	14.55%
2000-2009	43.54%	41.58%	22.22%	34.86%
2010-2017	51.17%	37.44%	77.78%	49.94%
Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**

Table 4. Percentage of Publications of each Innovation against Management Accounting

	Balanced Scorecard (BSC)	**Activity Based Costing (ABC)**	**Lean Accounting (LA)**	**Management Accounting (MA)**
1980-1989	0.00%	0.00%	0.00%	100%
1990-1999	23.90%	33.55%	0.00%	100%
2000-2009	82.00%	27.75%	0.49%	100%
2010-2017	67.27%	17.44%	1.19%	100%
Total	**65.65%**	**23.26%**	**0.76%**	**100%**

4.1 Balanced Scorecard (BSC)

In the first regression analysis BSC is the independent variable and MA is the dependent variable. This produced the following unstandardized coefficients which are utilised in the formula for the function zw = 567.46 + 1.231a and derived from Table 2 are the upper limit of 3,972 and lower limit of 0. These are then input into the formula as presented in Figure 2 below.

Figure 2. Measurement of Intensity of BSC

$$\tau = MAGINCH = log_{10}\left|\int_0^{3,972} 567.46 + 1.231a\ da\right|$$

$$= \left[567.46 + 1.231\frac{x^2}{2}\right]\int_0^{3,972} = 6.873$$

The result of this integral calculus formula is 6.873 which is the measure of intensity of this innovation.

4.2 Activity Based Costing (ABC)

In the second regression analysis ABC is the independent variable and MA is the dependent variable. This produced the following unstandardized coefficients which are utilised in the formula for the function zw = -147.087 + 4.512a and derived from Table 2 are the upper limit of 1,144 and lower limit of 0. These are then input into the formula as presented in Figure 3 below.

Figure 3. Measurement of Intensity of ABC

$$\tau = MAGINCH = log_{10}\left|\int_0^{1,144} -147.087 + 4.512a\ da\right|$$

$$= \left[-147.087 + 4.512\frac{x^2}{2}\right]\int_0^{1,144} = 6.445$$

The result of this integral calculus formula is 6.873 which is the measure of intensity of this innovation.

4.3 Lean Accounting (LA)

In the third regression analysis LA is the independent variable and MA is the dependent variable. This produced the following unstandardized coefficients which are utilised in the formula for the function zw = 1,377.969 + 70.146a and derived from Table 2 are the upper limit of 70 and lower limit of 0. These are then input into the formula as presented in Figure 4 below.

Figure 4. Measurement of Intensity of LA

$$\tau = MAGINCH = log_{10}\left|\int_0^{70} 1{,}377.969 + 70.146a\ da\right|$$

$$= \left[1{,}377.969 + 70.146\,\frac{x^2}{2}\right]\int_0^{70} = 4.877$$

The result of this integral calculus formula is 4.877 which is the measure of intensity of this innovation.

5. Discussion and Conclusion

Drawing on the analogy of the seismic measurement of an earthquake these innovations appear to have shaken the ground upon which the foundations of management accounting have been built. The scale of magnitude of the innovation change (MAGINCH) that each of these innovations on management accounting are all within the medium level of intensity as highlighted in Table 4.

Table 4. Scale of Innovation Intensity

Level Category	***MAGINCH = τ***	***Results***
Low	[0;4.5]	
Medium	[4.5;7.9]	*4.877 Lean Accounting*
		6.445 Activity Based Costing
		6.873 Balanced Score Card
High	[7.9; +∞]	

Whether they will completely supplant the traditional management accounting techniques is difficult to assess, at this stage what is apparent is that they have had an impact. In addition, there are modified versions of Activity-Based Costing and the Balanced score card. These new

developments may prove to be decisive in the future direction of management accounting.

This paper has sought to shed some light on the importance of the innovations in management accounting and provide insight into an evolving and new method for evaluating the relevant importance in terms of a scale of innovation intensity. As with early applications of most new analytical methods limitations are inevitable, and it is acknowledged that the measurement of the chosen dependent variable may be less robust than desirable, however, the intention of this paper has been to provide a useful surrogate for testing purposes. Future research may benefit from applying the scale of innovation intensity method to a wider set of innovations using more diverse forms of dependent variables in their application.

References

Chandy, R. and Tellis, G., (2000), "The Incumbent's Curse: Incumbency, Size and Radical Product Innovation", *Journal of Marketing*, Vol. 64 No. 3, pp. 1-17.

Coccia, M., (2005a), "Technometrics: Origins, Historical Evolution and New Directions", *Technological Forecasting & Social Change*, Vol. 72 No. 8, pp. 944-979.

Coccia, M., (2005b), "Measuring Intensity of Technological Change: The Seismic Approach", *Technological Forecasting & Social Change*, Vol. 72 No. 2, pp. 117-144.

Cooper. R., (1988), "The Rise of Activity-Based Costing – Part One: What is an Activity-Based Cost System?", *Journal of Cost Management*, Vol. 2, pp. 45-53.

Court, A., (1939), *Hedonic Price Indexes with Automotive Examples, The Dynamics of Automobile Demand,* General Motors Corporation, New York.

Garcia, R. and Calantone, R., (2002), "A Critical Look at Technological Innovation Typology and Innovativeness Terminology: A Literature Review", *Journal of Product Innovation Management*, Vol. 19 No. 2, pp. 110-132.

Green, S. Gavin, M. and Aiman-Smith, L., (1995), "Assessing a Multidimensional Measure of Radical Technological Innovation", *IEEE Transactions Engineering Management*, Vol. 42 No. 3, pp. 203-214.

Henderson, R. and Clark, K., (1990), "Architectural Innovation: The Reconfiguration of Existing Product Technologies, and the Failure of Established Firms", *Administrative Science Quarterly*, Vol. 35 No. 1, pp. 9-30.

Hu, Q., Mason, R., Williams, S. and Found, P., (2015), "Lean Implementation within SMEs: A Literature Review", *Journal of Manufacturing Technology & Management,* Vol. 26 No. 7, pp. 980-1012.

Ittner, C, Lanen, W. and Larcker, D., (2002)., "The Association between Activity-Based Costing and Manufacturing Performance", *Journal of Accounting Research*, Vol. 40 No. 3, pp. 711-726.

Johnson, H. T. and Kaplan, R. S., (1987), R*elevance Lost. The Rise and Fall of Management Accounting*, Harvard Business School Press, Boston.

Kaplan, R. S. and Norton, D. P., (1992), "The Balanced Scorecard: Measures that Drive Performance", *Harvard Business Review*, Vol. 70 No. 1, pp. 71-79.

Kaplan, R. S. and Norton, D. P., (2004), *Focusing Your Organization on Strategy: With the Balanced Scorecard 2nd Edn.*, Harvard Business School Press, Boston.

Kaplan, R. S., (1992), "In Defense of Activity Based Cost Management", *Management Accounting*, Vol. 74 No. 5, pp. 58-63.

Lancaster, K., (1966), "A New Approach to Consumer Theory", *Journal of Political Economy*, Vol. 74 No. 2, pp. 132-157.

Meyers, P. and Tucker, F., (1989), "Defining Roles for Logistics During Routine and Radical Technological Innovation", *Journal of Academy of Marketing Science*, Vol. 17 No. 1, pp. 73-82.

Modell, S., (2009), "Bundling Management Control Innovations: A Field Study of Organisational Experimenting with Total Quality Management and the Balanced Scorecard", *Accounting, Auditing & Accountability Journal*, Vol. 22 No. 1, pp. 59-90.

OECD, (1991), *The Nature of Innovation and the Evolution of the Productive System. Technology and Productivity the Challenge for Economic Policy*, OECD, Paris.

Pavitt, K., (1984), "Sectorial Patterns of Technical Change: Towards a Taxonomy and a Theory", *Research Policy*, Vol. 13 No. 6, pp. 343-373.

Saviotti, P., (1985), "An Approach to the Measurement of Technology based on the Hedonic Price Method and Related Methods", *Technological Forecasting & Social Change*, Vol. 27 No. 2-3, pp. 309-334.

Ruiz-de-Arbulo-Lopez, P., Fortuny-Santos, J. and Cuatrecasas-Arbos, L., (2013), "Lean Manufacturing: Costing the Value Stream", *Industrial Management & Data Systems*, Vol. 113 No. 5, pp. 647-668.

Van der Merwe, A. and Thomson, J., (2007), "The Lowdown on Lean Accounting", *Strategic Finance*, Vol. 88 No. 8, pp. 26-33.