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Digitisation, ‘Big Data’ and the transformation of accounting information

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Developments in digitisation, software and processing power and the accompanying data explosion create significant alterations, dilemmas and possibilities for enterprises and their finance function. The article discusses a model for understanding data, information and knowledge relationships. We apply the model to examine developments in strategy, organisational and cost structures, digitisation, business analytics, outsourcing, offshoring and cloud computing. We argue that organisations need to be sensitised to different types of knowledge, the challenges in creating and applying that knowledge, and be more circumspect about what can be achieved through advances in information-based technologies and software. We point to both the potential of and the complexities presented by Big Data in relation to the finance function generally and to management accounting information provision specifically. We suggest that ‘Big Data’ and data analysis techniques enable executives to act on structured and unstructured information but such action must recognise that the traditionally presumed sequential and linear links among corporate strategy, firm structure and information systems design are no longer in play. Additionally, cost structure changes are affected by developments in how data, information and knowledge can be utilised. We discuss the outsourcing and offshoring of work and their data, information and knowledge ramifications as well as those related to cloud computing. We conclude that the possibilities for the digitally enabled business create a range of ‘information literacy’ challenges as well as new possibilities for accounting information providers.

Keywords: data and information; types of knowledge; Big Data; outsourcing; management accounting; transformation

1. Introduction

Globally produced data double every 18 months, with data volume processed by organisations expanding by 35–50% per year. It is likely that the next 10 years will see a significant acceleration of these trends (Manyika *et al.* 2011). The proliferation of mobile devices, applications and operating systems, is altering how we work, what we work on, where we work and what

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we work with. The physical world itself is becoming a type of information system via the 'Internet of Things' (Chui *et al.* 2010) where everything is becoming connected to everyone. No aspect of business today remains untouched by digital technologies. This has led commentators to raise new possibilities for organisations in relation to altering the speed of their operations, the flexibility of their decision making, their strategic positioning and the reframing of achievable economic efficiencies. Major technologies affecting business today include mobile technologies, social media, cloud computing and 'Big Data'. The cloud has enabled enterprises to store, access and share resources at lower costs and with greater flexibility. Changes in sources and type of data collection are driving changes in channels of information transfer and what is regarded as analytically powerful data. Most of the data organisations collect, store, create and manage today are unstructured and cannot be easily retrieved or interpreted (Beath *et al.* 2012). The harnessing of unstructured data in ways impossible in the past has offered companies pathways to new business intelligence, more informed strategies and greater speed of service (Mayer-Schonberger and Cukier 2013). Additionally, developments in data, information and knowledge have considerable bearing on how outsourcing has been undertaken, with digital technologies having proffered the ability to carry out organisational activities at a distance. Coupled with this, the rapid rise of cloud computing arising from and further enabling a convergence of a range of technologies to run and to outsource applications, services and infrastructure over the internet raises important information- and knowledge-based consequences which are affecting the potential of accounting information provision within enterprises.

The use of new technologies and the data explosion affecting enterprises today create management dilemmas. By encouraging data volume, velocity and availability, and rendering data easier to store and cheaper to deal with, and offering the capacity to mix digital forms and supporting analytics, these technologies feed the data explosion and create data security issues they are also partly designed to solve. The finance function is being deeply affected by the advent of digital technologies. We assess here the technological, operational and wider changes taking place and their implications for corporate strategy and enterprise structure, organisational cost mix changes and the implications for cost management mechanisms, outsourcing and cloud computing, and organisational moves towards the digitally enabled business which implicate expanded roles for the finance function within enterprises and specifically for management accounting information provision.

The article first discusses a model for understanding data, information, knowledge and information systems. It then reconsiders the traditional links between enterprise strategy, structure and finance function activities and how digitisation is altering both their dynamics and the consequences for internal financial reporting, analysis and decision making. Second, we discuss cost structure changes and the continued applicability of established accounting tools. We highlight unstructured information and analytical data mining as inputs into the planning and control activities carried out by firms and the role of such information in rethinking enterprise objectives. In this light we assess the rise of 'Big Data' and the potential this offers for altering the premise on which accounting information provision generally aligns with within modern organisations currently. Third, we discuss the impact of the continued rise in IT-enabled outsourcing and cloud computing on accounting. We discuss how firms such as Microsoft and BP seek to standardise their infrastructure and processes globally through outsourcing and we explore the impacts of cloud computing and related technologies on accounting tasks and organisational forms. We conclude with observations on how digitally enabled business and the trends we discuss create a range of 'information literacy' challenges for accounting executives.

2. From data to knowledge

To assess the impact of digitisation on management accounting activities it is useful to consider documented conceptualisations of how data and knowledge relate to each other. The relationships between data, information and knowledge in a system used by agents – whether an individual, or an organisation, or a society – and how such a system can be seen as effective are of key relevance to understanding ongoing changes in accounting systems design. One conception of linkages between data, information and knowledge is to regard data as a record, information as message and knowledge as a model (of how something works). The components form an information system in receiving input, processing data into information and knowledge and producing outputs. At this abstract level Figure 1 can represent, with modifications in each case, how a computer system is designed to function, or how an individual, organisation or society might function.

Boisot and Canals (2008) characterise information as constituting ‘those significant regularities residing in the data that the agent attempts to extract from it’. They see data as originating in discernible differences in physical states of the world, in terms of time space and energy. However, an agent is needed – to be bombarded by these stimuli and sense some (or all) of it as data. But what constitutes a significant regularity can only be established with respect to the individual dispositions of the receiving agent. Moreover, data can only constitute information for an agent that is already knowledgeable. Knowledge is, in this respect, a set of expectations held by an agent and modified by the arrival of information. For these authors, agents have values as well as stored mental models. In Figure 1, an agent operates perceptual filters to orient the senses to certain types of stimuli within a given range. Stimuli passing through this filter get registered as data, but then conceptual filters extract information-bearing data from what has been so registered: ‘both types of filters get tuned by the cognitive and affective expectations . . . shaped as these are by prior knowledge . . . to act selectively on stimuli and data’. In this light, the utility of data is that it can carry physical information about the world, that of information lies in the fact that it can modify an expectation or a state of knowledge, while that of knowledge resides in it allowing an agent to act in adaptive ways in and upon the physical world. If this provides us with a plausible heuristic/normative model for discussing the issues confronting organisations, then we still need to delve more deeply into the knowledge aspects of the model.

Figure 1 distinguishes between tacit (uncodified, embodied) and explicit (capable of being clearly stated) knowledge. However, this is not regarded as a sharp division in practice. Scholars

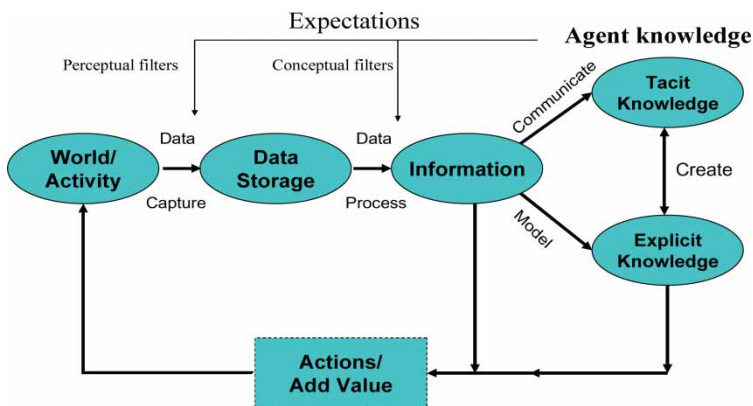


Figure 1. Data, information systems and knowledge.

Source: Adapted from Willcocks and Whitley (2009) and Boisot and Canals (2008).

also offer different perspectives on knowledge. Commentators belonging to the dominant difficulty school argue that tacit knowledge is difficult (but not in theory impossible) to articulate and formalise. Knowledge that does not face this difficulty is (or could be) articulated, formalised and codified (Nonaka and Takeuchi 1995, Zander and Kogut 1995). In contrast, the *de facto* school equates tacit knowledge with uncoded knowledge and opposes it to codified knowledge (Teece 1981, Boisot 1995, Alavi and Leidner 2001). Boisot (1995) asserts that ‘the issue is one of choosing which items to make tacit and which to ones to codify’ (p. 492), suggesting that the problem is not one of difficulty, but rather one of choice of where to focus attention. Those who see technology and software as being capable (eventually) of replacing all human action and judgement will see all knowledge as ultimately codifiable.

In contrast, we regard much of knowing as being embodied, and as socially created with meaning arising from context. Polanyi (1966a) further argues that even if knowledge has been articulated into words or mathematical formulae, this explicit knowledge must rely on being tacitly understood and applied. Hence ‘*all knowledge is either tacit or rooted in tacit knowledge*’ (emphasis in original). A wholly explicit knowledge, he argues, is unthinkable. Indeed, ‘(A) mathematical theory can . . . function as a theory only within an act of tacit knowing’ (Polanyi 1958, p. 21). In so doing, he emphasises the ‘knower’s active participation in any act of knowing’ (Polanyi 1966b, p. 4). Thus, if the knowledge management, and newer ‘Big Data’ and the digitisation literature were to stay true to Polanyi it would have to acknowledge the fundamental role that tacit knowing plays in all human knowledge-based activity.

However, this does not render machines useless. In their work on expertise, Collins and Kusch (1998) and Collins and Evans (2007) provide a categorisation of actions which can, in principle, be made explicit and hence performed by machines, and those which remain entirely within the realm of humans. They do this by distinguishing between polymorphic and mimeomorphic actions. Mimeomorphic actions are ones where we ‘either seek to or are content to carry out in pretty much the same way, in terms of behaviour, on different occasions’ (Collins and Kusch 1998, p. 31), for example, switching on a light. Polymorphic actions involve varying behaviour to carry out the same action in relation to a situation. This is due to the fact that a polymorphic action ‘takes its shape from society’ (Collins and Kusch 1998, p. 37), for example, telling a joke. The crucial point in their argument is that polymorphic actions cannot, as a matter of principle, be learned except through socialisation or apprenticeship; through ‘embedding within society’ (Collins and Kusch 1998, p. 88). On the other hand, the formula for a mimeomorphic action, provided it is not impossibly complex, can be ‘inscribed in temporarily decontextualised form, and is therefore transferable in a more straightforward way’ (Collins and Kusch 1998, p. 86), including by machines.

These considerations lead to a typology of tacit knowing as shown in Figure 2.

Because of the form of the knowledge, these issues become critical for business activities and for the finance function when reconsidering Figure 1. Technologies for data collection, storage and processing are matching the ongoing data deluge, and software for its sorting and analysis

Type of tacit knowledge	Typical reason
Knowledge that has not yet been formalised	Because of cost / time limitations
Knowledge that cannot be formalized	Because it is embodied
	Because of the form of the knowledge

Figure 2. Different types of tacit knowledge.
Source: Willcocks and Whitley (2009).

into information is continually being extended. The accountant's focus on the effective formatting of information for action by knowledge-vested managers is being impacted by the growth of data in volume and form which brings relevance to assessing emerging trends rather than focusing purely on historical data for guiding decisions (Bhimani and Bromwich 2010). This creates a potential bottleneck in Figure 1 at the point where information is to be translated into knowledge. A 'technologising' solution to this is to codify knowledge into a managerially usable form and subsequently 'informating' business activities (Willcocks *et al.* 2014). Big Data and business analytics software seek to enhance this conversion whereby patterns from large data sets are analysed to delineate patterns which may be deemed of managerial relevance. However, the types of tacit knowledge that either cannot yet be formalised, and more importantly cannot be formalised, and that may be the most critical components of organisational knowledge can go missing. Sensitivity to the limits, risks and connectivity consequences these developments bring is essential. For business generally and accounting specifically, Figure 1 suggests the need to consider not only the information system but the full-circuited knowledge system in place.

The value of such a perspective reflects also the need to assess the broader context in which data, information and knowledge reside, flow and operate. In particular, it is common for the management literature to suggest, amongst others, a contingency or 'fit' approach to organisational effectiveness, comprising variants of Levitt's 'diamond' (Levitt 1991). For our purposes, it is useful to consider a wider view (Sauer *et al.* 1997) which considers alignments among strategy, structure, technology, management and people/tasks which are regarded to be tied to organisational effectiveness. On a critical point, this literature rarely disaggregates to the level of information, data and knowledge, as we do here. In the next section we examine how changes in the relationships among strategy, structure, data, information and knowledge impact each other, and compound the challenges faced by rapid digitisation.

3. Strategy, structure and management accounting

In his studies of American conglomerates Chandler (1962, 1977) suggested that organisations have strategies to identify long-term goals, which become linked to courses of action and the requisite allocation of resources to achieve goals. He saw structure as the design of an organisation via which strategy is advanced. Thus a change in corporate strategy brings about new administrative challenges which necessitate an altered structure to support the newly advanced strategy. Chandler effectively argued that organisational forms necessarily derive from strategic pursuits and that this link has significant business performance consequences. Scholars have built upon and critiqued Chandler's notion of linearly conceptualised structure–strategy dependencies (Stigler 1951, Bain 1968, Marglin 1974, Williamson 1985, Livesay 1989, Argyres and Liebeskind 1999, Stack 2002, O'Sullivan 2006, Bucheli *et al.* 2010). Historical accounting change has also been explained via appeals to Chandler's earlier thesis on structure and efficiency (Chandler and Daems 1979, Johnson 1983).

The notion that organisational strategy defines firm structure which in turn is viewed to sequentially shape accounting system design is acknowledged by many with much evidence documented from investigations of industrial enterprises (see Dent 1990, Chapman 1997, Langfield-Smith 1997). Chandler and Daems (1979) posited the argument that in modern advanced economies, markets, firms and interagency arrangements are used as mechanisms for the fundamental functions of economic activity – namely, allocating, coordinating and monitoring. The modern hierarchical firm they argued from the end of the nineteenth century invested heavily in administering resource allocation, coordination and performance monitoring, whereby firms substituted the market and its price system through internalisation of these fundamental functions. Owners and managers of firms perceived a need to devise organisational structures and

accounting controls to permit the effective administration of allocative, coordinating and monitoring tasks at a cost lower than the market. Thus business enterprises responded to drastically changing technological and market requirements and opportunities by aligning their accounting systems to enable the discharge of critical economic functions. Standard costs, variance analyses, budgetary control and coordination mechanisms and measures of return on invested capital in multidivisional enterprises were accounting responses to altered organisational architectures driven by market determined strategies pursued by firms. Johnson (1983) advanced similar arguments concerning the role of management accounting in organisations. He argued that management accounting over a protracted period of time since the late eighteenth century can be regarded as having emerged to provide information essential to business owners and managers of entities which partially operate outside the market system. Organisers structure firms such as to earn returns from economic resources that are higher than those that can be achieved via ordinary market exchange. Management accounting techniques delineate the internally controlled domain of opportunities in which organisers can seek higher returns. The information provided by management accounting systems also affect the efforts made by employees of a firm to extract high returns from internally controlled resources.

Chandlerian arguments posit economically deterministic forces which accord specificity and sequential effects on accounting mechanisms in the light of organisational arrangements which themselves are reflective of enterprise pursuits. However, the social contingencies of organisational controls need also to be considered to allow for contextual differences in allocating, coordinating and monitoring practices to be explained. Such differences may be tied to the predilection for specific social and cultural control dependencies that are inherently part of certain managerial styles as opposed to the ideal that there only exists a uniform and standard affinity for formalised and structured financial information in the navigation of enterprise activities. In part, the sole appeal to formal reports which render explicit accounting information to enable managerial action cannot prevail universally across all situations. Information that is captured, 'technologized' and 'informed' cannot fully capture tacit knowledge which managers embed in their decision-making styles and which they prefer to further build upon from sources external to structured information processes. But styles of decision making are not the sole drivers of organisational uses of explicit knowledge and determinants of action taken.

Technology and the emergence of new information characteristics themselves also determine tacit versus explicit knowledge reliance. The movement away from pure economic transactions information captured by accountants towards other less structured forms of data capture will alter the mix. For many organisations 'strategic information has started arriving through unstructured channels; social media, smart phone applications and an ever-increasing stream of emerging internet based gadgets' (Lavallo *et al.* 2011, p. 29). In the modern digital economy, novel forms of information may alter strategic pursuits which will reconfigure organisational forms. What is regarded as financial intelligence will develop interdependencies with strategic posturing and enterprise structuring. Such information will alter the tacit versus explicit knowledge content mix, triggering executive action that does not recognise strategy–structure–accounting information linear relationships that have enjoyed conceptual legitimacy in the past.

Thus, the rise of internet-based technologies, digital products and web-based business models challenges the continued coherence of Chandler's premise. There is fast growing evidence that strategy–structure–accounting system design links do not follow a sequential path of effects in digitised age organisations (Bhimani and Bromwich 2009, 2010, Willcocks *et al.* 2014). Inter-dependencies exist in enterprises whereby the three are now co-mingled. Business strategies often presume technological form which may be responses to rather than triggers of financial information provision. In effect, the inter-dependencies between strategic, technological and

operational decisions within many organisations imply that managerially useful information can no longer presuppose the separability or sequentiality of strategic intent and technological options. What comprises relevant information and the presumed sequence of its deployment vis-à-vis management action in the organisationally networked world has to be reconsidered (Bhimani and Bromwich 2010, Bhimani 2013a, 2013b). Information systems now need to deal with this transformed sequence as well as the altered form of information to be processed and the tools essential for analysis.

The rapid pace of digitisation is forcing deep changes in the *modus operandi* of management structures, decisions and strategies. It is giving birth to novel business models with concomitant financial management repercussions (Zott *et al.* 2011). Aside from technological advances affecting new organisational forms, the ways in which businesses create and transform information from one type to another are reshaping how they advance innovations in the creation of corporate value. Finance managers are now viewing the swift pace of change they face in their organisational environment as the only constant and recognise that as viable modes of information access, analysis and reporting alter, so must the services they provide.

Computers have shaped business activities for over four decades. But it was only during the mid-1990s that a profound second wave digital revolution took place. At that time, three effects became interlinked: the spread of user-friendly operating systems and interfaces; the rapid diffusion of the internet and the worldwide web; and the convergence of four formerly distinct industries – computers, software, communications and media and entertainment (Bhimani 2013b). These three factors led to the creation of a huge worldwide value network with attendant new business models and novel ways for enterprise architectures to form and enable the generation of wealth and the creation of economic value. Concomitantly, for many organisations novel types of business intelligence began to crowd out traditional sources of information and as Chen *et al.* (2012, p. 1167) note today's business community and industry have taken 'important steps' to adapt such that the '... decade of the 2010s promises to be an exciting one for high-impact business intelligence and analytics research and development for both industry and academia'. But Bharadwaj *et al.* (2013, p. 477) note that for now: 'As companies make investments to process increased amounts of data, we find that few have made corresponding investments in the organisational processes to drive business value from data and information.'

Enterprises have in the past designed accounting systems to produce formal information which systems users purposefully deploy to gain an understanding of how economic transactions reveal information about the types and trends of consumer purchases. What consumers do which results in economic transactions has always shaped what enterprise executives seek to derive from accounting information systems. But a shift in information design structures is currently taking place. There is now a realisation that the information which information systems have traditionally discarded because of the lack of a direct link to economic transactions can be of significant relevance and usefulness as a source of business intelligence for companies (Bhimani and Bromwich 2009, Bhimani 2013a). A customer making online searches and collecting product information will leave a trail of information disclosure about choice and information assessment prior to making the purchase. This 'data exhaust', if effectively captured and analysed, can help organisations determine how customers search and arrive at the purchase point and the specific path dependencies of buying decisions. Google.com for instance learns from every search process carried out and generates greater search value, as the magnitude of prior searches grows. Amazon.com gathers information from online customer behaviour irrespective of whether a purchase is made. EBay monitors buyer and seller activities even where no bidding transactions take place (Gneiser *et al.* 2012, Hanafizadeh *et al.* 2012, Vogelstein 2012). Such information at an aggregate level enable predictive customised marketing strategies to be deployed. Data that are non-economic transaction related and derived via the analysis of data exhaust offer the potential

of developing financial intelligence and shaping cost management as well as pricing and operational control decisions.

The sequence of information gathered as well as the length of time of information exposure, the emphasis placed on pricing and the assessment of other factors such as questions asked and service level evaluation by a customer making a purchase decision allow predictive intelligence resting on the antecedents of economic transactions. This form of information has not normally been central to accounting data compilation activities in organisations. But some enterprises (Brown *et al.* 2013, Davenport 2014) are beginning to extract new insights from existing and newly available sources of information in defining their technology and strategy. Ultimately, they take steps to ‘incrementally upgrade their technology infrastructures accordingly’. (Schroeck *et al.* 2012, p. 3). Technology, the availability and sophistication of analytical methods and the lowered costs of such intelligence assessment today point to potentially new roles for finance professionals as information specialists. More widely sourced information content within accounting reports point to the capacity for using information to alter corporate strategy rather than simply to support it and for effecting restructuring rather than merely to promote alignment with ready existing organisational arrangements.

Drawing business intelligence from information produced in the absence of economic flows such as from searching behaviour, website visitations and browsing sequence has, for some companies, become a necessity in understanding emerging trends, developing new products or devising selling strategies and in creating competitive entry barriers for new entrants who can replicate the basic business model with ease but not the knowledge base already developed by leading market incumbents. The significance of harnessing such business intelligence is growing apace. Recognising the value of ‘Big Data’ and developing the ability to apply data analysis techniques is for many companies coming to be seen as essential to allow their executives access to empirical information, both structured and unstructured, relating to market trends and customer behaviour. The sequential linearity between strategy which defines structure which in turn shapes information systems design in this emerging context plays a lesser role than has traditionally been assumed. Some scholars predict a convergence between information systems and strategic domains (Bharadwaj *et al.* 2013, Drnevich and Croson 2013). It is plausible that accounting information systems will continue to see changes – some along these lines.

4. Changing cost structures

Investments in technology and hardware for use in production have always tended to affect cost structures. Fixed asset structural investments require longer term amortisation, as expenses are preceded by expenditures of a much greater magnitude. The trend towards digitised investments makes fixed costs particularly pronounced across every organisation opting for such expenditures. Digitisation is typically accompanied by fixed cost incursions which far exceed variable cost elements (Afuah and Tucci 2001, Bhimani 2013a). Within highly digitised firms which provide a range of products and services, determining costs per item produced or delivered becomes difficult, if at all possible. Approaches such as functional costing and activity-based costing offer some information content of value to managers but only to a limited degree as the variability of costs in digitised operations is disconnected from traditional volume and non-volume-based cost driver demarcations (Bhimani and Bromwich 2010). Indeed the definition of a product is not always clear in web-enabled commercial contexts where the contours of the product are not readily definable and often alter over time. Moreover, customers who cause the generation of a firm’s revenues may not be key consumers of resources. Revenue sources do not always coincide with the organisational product offerings that are consumed. Costs may be linked to the provision of a technological platform for consumers, but revenue sources may

arise from the number rather than the activities or services consumed by users. Internet ‘pure plays’ operate very frequently on radically different commercial models and a different business logic relative to traditional firms (Mahadevan 2000, Pauwels and Weiss 2008, Chesbrough 2010, Teece 2010, Thompson and MacMillan 2010, Brynjolfsson *et al.* 2011, Bhimani *et al.* 2012, Open Data White Paper 2012). Sources underpinning line items in an income statement for a digitised firm have to be analysed in ways which depart from what users of financial statements traditionally expect (Bhimani and Bromwich 2010, Bhimani 2013b). Conventional approaches to financial reporting analysis and cost management can be of limited value in organisations that invest heavily in digitised technologies.

Many e-businesses have invested in revenue generation models where consumers access web-based platforms from which they derive value. The technological platforms are sources of cost incursion for the provider with revenues being sourced from different streams including adverts directed at specific user groups, market experimentation based on platform reconfigurations, valuable consumer intelligence derived from Big Data analysis produced from the exhaust trail left behind by consumers and cross-sales opportunities to existing consumers (see Davenport (2014) for examples (see also Bhimani and Bromwich 2010). Cost side items relating to the technology seamlessly tie into revenue generating activities in ways which conventional accounting systems have not had to confront. Tracking income where usage yields costs that occur at the same time as revenues get generated but where costs incurred are not caused by the customers’ revenue generators, requires financial intelligence which few accounting systems have traditionally incorporated within their design. Accounting system designers will need to develop ways in which income statements intended for managerial use capture the changing dynamics of cost and revenue sources. Additionally, in such contexts, what defines pricing strategy, quality costs and product life cycle costs will require rethinking given both the differentiation between products used by consumers and customers who produce revenues, and given the receding boundaries separating producers from consumers in relation to traditional enterprise forms for which accounting systems were designed.

The arguments presented here signify that the finance function’s objectives in relation to information output will alter and will need to be comprehensively assessed as both the sources and the modes of analysis of information alter. Some traditional challenges of accounting information provision remain. Organisations require users of information to understand managerial styles of information deployment (Argyris and Kaplan 1994, Birnberg and Shields 1989, Bruns and McKinnon 1993, Shields 1995). The altered nature of data will require the analysis of structured and unstructured data that is ultimately management decision making focused whilst drawing on widely different channels – some micro-level and specific, and others more aggregate, raw and amorphous. In new financial information environments, accounting professionals will not need to develop specialist technical expertise in data manipulation and analysis but will have to understand the potential that such data assessment proffers and the value and implications this has for the financial intelligence they will provide.

Novel accounting techniques which have found growing deployment in many manufacturing and service-based firms will play a narrower role in the emerging digital economy relative to the industrial economy and even the information economy (Castells 2009) that prevailed just a decade ago. Whilst many enterprises today deploy tools such as activity-based costing, target costing, functional costing, life cycle costing and strategic cost analysis, their relevance in increasingly digitised environments will require rethinking. A case in point is the Li & Fung group founded in 1906. The group has today activities in export sourcing, distribution and retailing with over 26,000 employees across 40 countries and with revenues exceeding US\$21 billion in 2012 and is the world’s largest outsourcer in the garment industry. Li & Fung is in effect a virtual company with collaborative links, acting as a value chain coordinator. It does not own any

manufacturing capability but rather, coordinates a network of over 10,000 suppliers. It provides an example of a company which has increasingly experienced a co-mingling of strategy, technology and cost management tied to the possibilities offered by digitisation of its activities including its information systems. The relatively recent application of modern cost management practices within such companies is witnessing a reshaping of their roles and effects (Bhimani 2003, 2006, Bhimani and Bromwich 2009, 2010). Alterations in the cost mix of products and shifts in cost behaviour will lead not to a dispensation of decision-making approaches which have long been established but a re-assessment of how cost changes can translate into alternate and renewed business strategies (Afuah and Tucci 2001, Brousseau and Penard 2006). New business models that drive different costs of varying magnitude and which are integrated into economic value creation in different ways will place altered demands on the finance function. Managers in some firms that are fast developing digital capabilities or that are widening their product offerings and broadening their production bases to achieve greater deployment of digital technologies will seek information that capture a different order of data. Events in the real world that are unstructured but that influence economic value creation either directly or via intuitive representations of how consumers predictively behave will need to be grounded into financial reports. Likewise, structured information will come from a more diverse set of sources, activities, processes and devices. The accounting domain within firms will need to confront a differing level of significance accorded to data capture and to the processing of that data into formatted reports such that it conveys sufficiently salient financial intelligence to managers who themselves will be able to access a knowledge base significantly different to that available to industrial era predecessors.

5. Big Data: a changing role for accountants?

The pace of data growth we are witnessing today is partly reflective of the increase of media, entertainment and social networking possibilities online. While much of the information is unstructured, a significant proportion is amenable to structuring in an economically purposeful sense. The significant data growth for enterprises translates into greater access to customer data from public, proprietary and purchased sources as well as novel information obtained from new 'smart' sources and net-communities. The availability of Big Data is starting to sponsor new directions in enterprise innovation, research and marketing with attendant consequences for the finance function. The growth of Big Data sources alongside the possibilities presented by 'data exhaust' analysis enables immensely useful analyses of the business environment and managerial action in ways not seen or viable before. For instance, purchases made via Amazon are often tied to purchases made previously. Probabilities can be established about the likelihood of particular subsequent purchases being made based on data collected about macro-level buying behaviour, non-purchases and prior online interactive searches. eBay likewise continuously alters its listings based on prior listing activity, bidding behaviour, pricing trends, search terms used and purchase frequency. Google searches become more and more relevant because search results are based on what users with prior similar searches eventually stayed with. In this sense, data trails left by web surfers invite more rigorous data analysis and mining whose results can point to altered pricing policy, cost containment prioritisation and cash and working capital management strategies. To retain relevance of information provision, finance executives will need to confront making investments into new domains of expertise.

Professional accountancy bodies recognise the need to better understand how Big Data could shape accounting practices:

Big data is increasingly becoming a core business asset. (Peter Simons, Technical Specialist, CIMA; Simons 2013)

The growth of big data together with increased processing power, sophisticated algorithms and advanced statistical methods suggest that there should be many opportunities to improve management reporting and understand the connections between financial and non-financial measures. (Robert Hodgkinson, ICAEW, Executive Director, Technical and Kirstin Gillon, ICAEW, Manager, IT Faculty; Hodgkinson and Gillon 2012)

Big data offers the finance professional the possibility of moving into a more strategic, proactive role in business. (Faye Chua, Head of Future Research, ACCA; Chua 2014)

While data mining, data exhaust assessment and other data analysis trends can feed positively into financial and management decisions relating to revenue generation, cost containment and product strategies in enterprises, there exists little empirical evidence of a large-scale re-orientation of the finance function towards the harnessing of these emerging information possibilities. Financial information systems oversee organisational processes and revenue generation activities which coincide with specific income statement line items. Enterprises have always made decisions based on both verifiable economic transactions which affect the bottom line and on insight as to where growth or value creation opportunities may lie. Presently, however, organisations are faced with using objective data sources that are structured and unstructured and having to swiftly delineate paths of activities that engage strategic action whilst grounding real-time reactions to operational issues.

Consider the collection of information taking place from within products and processes themselves. Real-time data collection can be achieved without separate information systems being in place through the use of, for instance, pill-shaped micro-cameras, precision agricultural and industrial sensors and radio frequencies identification tags. Different working capital management choices are presented in contexts where products and processes themselves act as collectors and transformers of information. This presents novel possibilities for accounting information activities whereby the finance function can become a receptor and assessor of information for real-time analysis and decisions. Likewise, continuous information collection that provides an understanding of the path dependency of product purchases and informs executives about cost incursions which may be distinctly separable or common given the pricing strategy adopted presents new challenges for accounting information systems. The 'Internet of Things' may possibly generate Big Data that will undergo analysis and be transformed into 'predictive algorithms, and programmed into automated systems to ... dramatically increase productivity, and reduce the marginal cost of producing and delivering a full range of goods and services to near zero across the entire economy' (Rifkin 2014, p. 11).

The analysis of Big Data moves the information professional away not just from historical to real-time processing but also from a focus on samples. Entire data sets become analysable to determine unknown unknowns. Queries on this data can also be much broader. Where the data between internal and external data sources are less important and constraining, wider questions about interrelations can be asked. This presents a new world of possibilities as well as challenges. The real-time analysis of total data sets with broad questioning options lies at the heart of what Big Data offers enterprises.

Data scientists with an understanding of quantitative and statistical techniques can assist in shaping information provision but it is clear that 'bimodal athletes' (Court 2012) are essential. Training with Big Data sets enables the posing of specific questions. But understanding the business is essential in demarcating what questions to ask. Accountants understand R&D, engineering, manufacturing unit activities and the marketing and sales function in relation to financial flows and perhaps also to a degree operationally. Big Data allow the integration of data from these functions and foster addressing different types of questions. The accounting mind-set provides a ready perspective on what could be asked if an appreciation of the potential of data analytics pre-exists.

Altering modes and systems of data manipulation from an accounting information angle within enterprises is a major challenge. Another is that data-driven prioritisation of activities in enterprises relies on different notions of autonomy and control. On the one hand, managers operating in a highly digitised environment engaged in Big Data analysis tend to engage in collaborative working approaches rather than command and control work styles. Trust and visibility are given a high degree of importance and co-exist with a predilection for multi-platform interaction and interfacing. Consequently, managers increasingly reveal a need for constant real-time feedback about their activities. Performance evaluation systems, including accounting and financial metrics based indicators need to match this. Information systems that produce output which is qualitative, quantitative, graphical, interactive, text-based and which shows varying degrees of structure will be increasingly invested in. The impact on both the work content and work style of accounting professionals is likely to be extensive (Bhimani 2013a).

The availability of Big Data is bringing in also a possible redesign of ways of organising executive responsibilities and rewards. Its analysis in firms entails novel incentive and responsibility structures. In a digitised and globalised complex enterprise, people can act whilst thinking about desirable actions. Actions subsume or include objectives. That is, objectives become defined simultaneously with actions and are embedded in actions. Processes therefore become concomitant with intentions. Management thinkers in the past have mostly regarded decision-making activities and managerial action as being sequential (Bhimani and Bromwich 2009). The notion that some organisational actors think, whilst others engage in action, is less and less a characterising feature of enterprise activities today though still prevalent in some industries. Conceiving ways of doing things is often regarded as an activity that is distinct from the actual execution of desired activities. When it becomes evident to an enterprise that strategic processes and related organisational, structural and informational provision issues are closely intertwined, the need to act on information-based insights in an instantaneous manner comes to be seen as essential. The management of an organisation embracing data analytics requires also a particular integration of decision making and action.

Many accounting systems remain archetypical to the presumed sequentiality of managerial thought–action. But the distance between analysis and execution by managers is being eliminated in enterprises confronted with Big Data opportunities, and the creation of compatible ‘closed loop’ performance management systems becomes a requisite. The accountant’s understanding of performance metrics, management assessment parameters and incentives must be appealed to in setting up new responsibility and reward structures in enterprises.

At the same time as accountants move towards Big Data and business analytics, they must exercise caution. Big Data do not necessitate a wholesale and unthinking adoption of an altered set of managerial controls. Big Data actively encourage further data and information overload, a worry acknowledged by many chief financial officers in a recent study (Economist Intelligence Unit 2013). To a degree large data set analysis to detect patterns adds to developing an understanding of causation and enables hypothesis testing and expert judgement within firms, but Big Data is not of necessity more valuable than smaller data sets. It brings with it its own statistical analysis problems. ‘Data rich’ does not easily translate into information empowered and knowledgeable environments. Data quality continues to matter and its importance cannot be swept away by bigger samples. Very large datasets can be messy and the number of variables may need to be reduced to make the data more manageable. If there are inherent biases in data analysis and collection (see Figure 1) larger datasets will not help. For some phenomena, historical (i.e. long) data can be required as much as Big Data. Enterprises are becoming cognizant of such limitations before engaging in Big Data and business analytics, or hiring service providers to do this work.

6. Outsourcing and cloud developments: whither digitisation?

A long-term trend across Western economies has been the growth in offshoring and outsourcing of organisational work.¹ Outsourcing is the handing over of the management of a function, assets, people or activity to a third party for a specified cost, time and level of service. There are other ways of using external services, including buying in resources to operate under internal management control (Willcocks and Lacity 2012, 2013). Current developments in data, information and knowledge have considerable bearing on how outsourcing/offshoring can be accomplished, and with what levels of effectiveness. On the one hand, digital technologies are a major facilitator of outsourcing work, and performing that work at distance. But on the other hand, a number of data, information and knowledge dilemmas arise. The rapid rise of cloud computing as a convergence of a range of technologies so that applications, services, infrastructure can be run, and outsourced, over the internet renders how to source an even more information and knowledge loaded question. We explore these issues below.

According to Fersht *et al.* (2013) while outsourcing buyers are perceiving cost-reduction and efficiency of delivery – they do not always benefit from innovation, analytical capability and skilled talent to define business outcomes. For accounting activities the offshore model is still in question for operational value beyond basic administrative services. The evidence has pointed to enterprises geared up for achieving tactical measures but lacking the skills to be analytical and innovative. What is noticeable from the research is how organisations rarely analyse systematically the knowledge, data and information implications of their outsourcing/offshoring decisions (Lacity *et al.* 2011). On these, we would highlight some key challenges that, in practice, outsourcing produces for accounting activities.

The first challenge is deciding on core capabilities and how far to differentiate between activities in relation to organisational value. One perspective is that accounting and other enterprise functions might seek to centralise and standardise low value added work such as transactions processing and payroll through shared service centres or outsourcing the work to third parties (Payne 2009). Only staff carrying out more value added work requiring idiosyncratic knowledge and judgement – such as business analysis, decision support and strategic input – need to be situated closer to business decision makers. For the finance function, these would be in the controllership and strategic transformational areas. Such staff and their functional heads may be urged by their advisers to pursue positions as ‘business partners’, whereby they aim for lead roles in strategy, decision making and driving change. Different views exist in regard to sourcing options. Critical differentiators – activities, knowledge, skills that differentiate in the market place and underpin strategic direction – tend to be kept in-house. Critical commodities (e.g. aircraft maintenance systems, open accounting) and useful commodities (e.g. payroll, data centres) are, in principle, seen to be outsourceable, provided a cost effective supplier can be found to deliver to the required levels of quality and security (Cullen *et al.* 2014).

Sourcing decisions have considerable data, information and knowledge ramifications that must lead organisations to consider parts that may be core and those that are commodifiable, and so more amenable to outsourcing. An organisation may well decide that operational analytics, reporting and certain information tasks are indeed commodities and can be outsourced but it will need to, possibly via finance and accounting intelligence, seek to determine whether the necessary safeguards and quality of service are in place to protect its strategic positioning. In relation to data storage and processing, these may be viewed as commodities but outsourcing will still raise security and privacy concerns. In terms of other firm resources, strengths and activities, there are dangers that fast movement towards Big Data and business analytics services will culminate in serious – and possibly expensive – distractions from developing an information and knowledge strategy reflecting and shaping an organisationally embedded view that supports the key business imperatives.

In practice, defining core capabilities is a difficult task, not least because what is 'core' firstly changes over time, as business strategy and requirements change, and secondly is organisationally dependent. Moreover, outsourcing incurs transaction costs, risks, conflicts of interest and exposure to suppliers of services that a finance professional may not be able to warrant even for 'commodity' activities and skills. One of the key roles of internal accounting activities is to track service provider maturity and capability. Feussler *et al.* (2013) note that the developing digitally enabled business environment is altering what is asked of accounting professionals. Outsourcing decisions become a key issue facing accountants in determining what to continue/begin to undertake in-house. Often the decision is that the activity is still best done in-house, sometimes as shared services, less often as an offshore captive (Fersht *et al.* 2013). At the same time, process standardisation, and the new focus on process and work automation alter what is considered to differentiate, thus requiring reconsideration of what has previously been defined as specialist knowledge (Young 2013).

A further challenge is the shape-shift of back office functions from 'pyramids' to 'diamonds' (Lacity and Willcocks 2012a, 2012b, 2012c) taking place as a significant trend in IT, Finance & Accounting, Indirect Procurement, and Human Resources functions. Pyramids are organisational structures viewed as heavily populated with employees, most of whom are at the bottom of the pyramid. The benefit of this design is that employees continually build valuable, client-specific experience as they are promoted higher up the pyramid. The pyramid model is strong on retained knowledge, but it is also costly. Back office managers must compete for effective and sometimes expensive domestic workers to fill in skills gaps and to scale up resources. The pyramid model is also characterised by a significant class of middle managers who manage both employees and supplemental staff.

Diamond-shaped organisations replace the heavy bottom of the pyramid with providers who offer labour, but also, increasingly, automation. Many transactional activities once performed by employees are accomplished now by providers, typically in a lower cost location. There are fewer middle managers, but more 'Subject Matter Experts' and 'Project Leads'. The diamond-shaped organisation also needs more quality assurance and governance skills to coordinate services with providers. The potential benefits of the diamond-shaped retained organisation are seen to be lower costs, access to providers with best-of-breed skills, and greater flexibility because providers can adapt more easily to increases or decreases in service volumes. Moving from pyramid to diamond structures can have redistribution effects, accelerated by digital technologies, on where data, information and knowledge reside and how they are utilised. These changes, we would argue, need to be very carefully managed.

A further challenge is that the possibilities and trends discussed so far suggest the necessity for smaller, but more high performing internal IT, HR, procurement and accounting functions than has traditionally been the case. Cullen *et al.* (2014) identify nine core capabilities that need to be retained in such a model. In Figure 3 we illustrate these with the example of the accounting function. Relationship building, business systems thinking, service delivery and leadership look towards the business and its requirements. The technical, process and knowledge architecture is secured by the architect and technical/process 'fixer', while external supply is leveraged through contract monitoring, provider development, informed buying, and service delivery roles. The nine roles in this model all demand high performers who can develop into a 'high-performance' team. All these roles require people extensively knowledgeable in their specialist area, for example, corporate finance, management accounting, HR, IT. But in contrast to the more traditional skills found in accounting, IT, HR and procurement functions in some contexts, a greater emphasis on business skills and business orientation in nearly all roles is often perceived to be desirable. There is a significantly increased requirement for 'soft' skills across roles in many firms. The major shift observed in organisations such as Esso, ICI, DuPont, Commonwealth

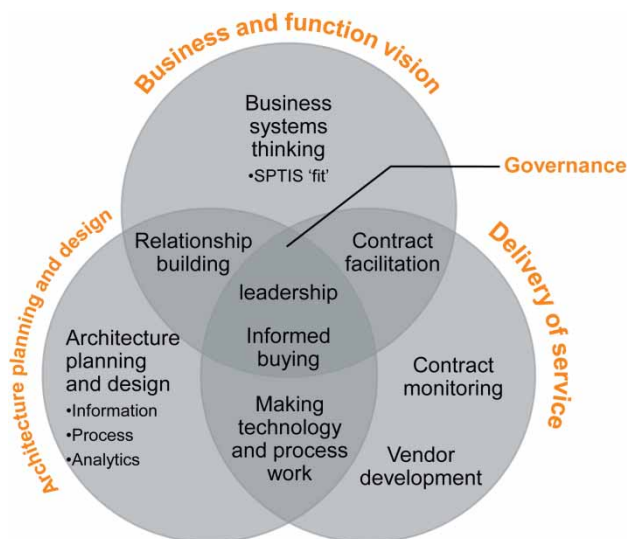


Figure 3. Finance and accounting function core capabilities.

Source: Cullen, Lacity and Willcocks (2014).

Bank, Lloyds of London, BP, Procter and Gamble, and GE is towards fewer personnel with greater business skills and business orientation (Willcocks *et al.* 2014).

The evidence is that moving to such a model creates large challenges for executives (Willcocks and Griffiths 2010). Making explicit where responsibility for data, information and knowledge reside remains an abiding issue. In practice, security, privacy and regulatory dimensions must be considered, and data and information skills need to be suffused throughout the capabilities. The internal function we outline is a dynamic knowledge repository, able also to manage and leverage data and information for organisational purpose where people and their abilities and managerial styles are as important to consider as the technologies, processes, and the data, information and knowledge they carry.

Offshoring presents a further challenge. In practice, the data, information and knowledge implications of offshoring have been considered relatively carefully by businesses, due to the more obvious risks of losing vital knowledge, or compromising information privacy and data security – as noted above (Cullen *et al.* 2014). In the last two years, however, with cost and performance pressures to the fore, businesses have increasingly looked to outsource more of their knowledge-based work, as we have witnessed in accounting and legal services work (Lacity *et al.* 2014). Organisations have also increasingly looked to offshoring not just for data storage and processing, but also operational information processing, thus taking advantage of the powerful information and communication technologies now available. More problematic is where information and knowledge work require polymorphic rather than mimeomorphic actions. Polymorphic actions cannot be outsourced effectively unless there is strong cultural and institutional compatibility, for example between the UK and the Indian institutional environments for accounting work, or the UK and the South African institutional environments for legal services, and even then there is a learning curve for client and service provider in how far work involving end customer interaction and higher value can be outsourced (Lewin and Peeters 2006, Maelah *et al.* 2012, Lacity *et al.* 2013a, 2013b).

Another significant challenge arises in relation to cloud computing, which consists of internet-based remotely hosted data centres, platforms or applications run either internally, or by external

service providers, or a mix of these. Cloud computing also supports three other technological developments – social media, Big Data/analytics and mobile-based applications – that in combination form a basis for moving towards digital business, or what has been called ‘the cloud corporation’ (Willcocks *et al.* 2014). Uses of these technologies will continue to produce concomitant management and accounting dilemmas (Bhimani and Bromwich 2009, Bhimani 2013a, 2013b). For example, at the moment social media is used for connecting to customers and for recruitment. At the same time they bring dilemmas over privacy, and legitimacy of use. Mobile-based applications are already used for improving customer service, employee collaboration and productivity while reducing operating and communication costs, and moving to a pay-per-use model using service providers. But ‘bring your own device’ policies require changes in technology architecture and create security concerns (Sorensen 2011). Big Data and analytics already support examples of real-time micro-segmentation of customers, and have the potential to reduce risks, alter business decisions, and point to possible valuable assets. But much depends upon the quality of data and automated and expert analysis, and cultural changes in how information are collected and exploited (Quayle and Mataya 2013, Willcocks *et al.* 2014).

From our cumulative work on cloud computing, we consider problematic over-optimistic estimates of the rapidity of adoption and size of market. For now, cloud computing cannot achieve the plug-and-play simplicity of electricity. We are finding that the hype suggests a seamless fast introduction of cloud, but this does not do justice to the lengthy process of diffusion. Very recently, many adopters were seeking to fit cloud with their existing technology trajectories and business plans, rather than organising around cloud as the panacea presented in many discussions on the subject. In most areas, there is, as at 2014, pragmatic adoption of discrete applications, which can be expected to accumulate over time into much wider, and eventually pervasive adoption. Large enterprises like Procter and Gamble, Johnson and Johnson, and Tango Card and small and medium enterprises like The Dana Foundation, Diesel Direct and Art-World provide evidence of the challenges we have discussed on moving towards cloud policy and adoption (Lacity *et al.* 2013a, 2013b, Willcocks *et al.* 2014).

Cloud computing is a vehicle which resonates many of the issues we have identified in this article, and representational of the digitally enabled business – more virtual, outsourced and information-based – that we have anticipated elsewhere (Bhimani 2013b, Willcocks *et al.* 2014). Cloud computing can be regarded as a catalyst for more innovation particularly given its service (and service quality) focus, coupled with the flexibility that new technology delivery mechanisms provide. In becoming cheaper and more ubiquitous, the possibilities for combinatorial innovation will likely grow (Willcocks *et al.* 2014). Interestingly, we have found that these features serve to change the risk profile of business innovations. It is now increasingly possible to quite quickly and cheaply specify new business processes and their service levels, experiment with them and then disband them if they are unsuccessful or rapidly scale those that have potential.

Outsourcing will continue its steady growth over the next several years, and practitioners will need to consider their ability to assess and leverage how they use external service providers in seeking to achieve further economic value. Part of this will involve assessing the relatively new services being offered by external providers, including in Big Data and business analytics, process standardisation, global business services support, and offerings, cloud, and service integration. Throughout, a need will be perceived to examine the data, information and knowledge ramifications of alternative global sourcing arrangements. As real-time, accurate data in massive quantities become increasingly central to digitising businesses, integrated information and knowledge systems based on the internet and organised seamlessly with and through service providers will increasingly require deeper and more detailed financial analysis.

Cloud computing, along with social media, Big Data/analytics software and mobile technologies present potentially radical challenges to business generally and to accounting activities specifically. Moving to the lynchpin technologies represented by cloud creates security, legal, supplier contracting and lock-in risks, and produces significant management challenges, including maintaining strategic control, managing cloud services and dealing with the organisational, cultural and integration challenges (Willcocks *et al.* 2014).

7. Discussion and conclusion

Through crisis and stability, enterprises have looked to the finance function in seeking to maintain an efficient and effective operating model via the provision of financial information for guiding control decisions. Much of the agenda for the provision of accounting information in the light of the rise of Big Data and the ‘information literacy’ challenges and trends we have discussed here will in some organisational contexts undergo a transformation. Understanding the key role of data integrity throughout collection and processing stages, designing work on the basis of a more elaborate understanding of knowledge, enabling enhanced deployment of emerging technologies for data capture and analysis, and adopting more nuanced analyses of the strategy-control links, cost management complexities and outsourcing and cloud-based possibilities, will prove to be of increasing concern to accounting information providers. In this final section, we draw out some implications for how accounting practices are likely to see shifts in the light specifically of the growth of Big Data and related informational changes taking place today.

Information technology changes inevitably alter information collection and analysis for management and control activities. There are inherent changes in the role of financial information provision given the extensive diffusion of information in combination with novel IT forms for its collection and analysis. Smith and Payne (2011) note that finance function activities such as accounting, compliance, management and control, strategy and risk, funding and resourcing are facing challenges and tensions today across organisational settings. They suggest that ‘relentless IT development may have a transformative impact on the implementation of finance activities and also provides an ongoing challenge’. We have noted how developments in data, information and technology are now becoming so extensive that a fundamental shift in accounting is taking place across many organisations and re-assessing the potential of financial information change in this changing information context is viewed as desirable. We are at present seeing the furthering of a trend that started to emerge over two decades ago in relation to the expansion of the influence of senior accounting executives beyond financial decisions to broader strategic choices about business and operating models (Bromwich and Bhimani 1994, Bhimani 2013a). Our research has found several examples of organisations making such shifts. As one example, a global data warehouse, standardised metrics and sophisticated reporting capabilities supported the strategic transformation of a diversified and multi-layered international mining company into a unified and integrated global organisation. We identified a number of core technology-, management-, culture-, governance- and people-related capabilities that were seen as crucial to the effectiveness of the global transformation initiative. The case highlighted why business analytics systems were regarded as requiring alignment with IT and business strategy and the role of interaction between business analytics systems and other organisational resources in the pursuit of enterprise aims (Shanks *et al.* 2013). Further examples we have researched lie with Microsoft and BP who have used their major service providers to both standardise globally their accounting and finance functions, and successfully drawn upon provider expertise to both move to the cloud and also generate business analytic capabilities that were beginning to shift accounting into more strategic roles in these corporations (Lacity and Willcocks 2012b, Willcocks and Lacity 2013).

There is growing evidence of instances of accounting executives seeking to go beyond their traditional tasks of maintaining an efficient and effective operating model to deliver financial integrity and guiding decisions about enterprise operations. Accounting information – through the filters of advanced IT and business analytics tools – are being deployed in some enterprises to alter business decisions by, for example, developing deeper and wider levels of analysis much faster, identifying key new trends from which prescriptions can be extracted. Such deployment is starting to change how the finance function articulates the possibility for altered uses of resources and ways of pursuing corporate strategies.

Current and impending developments in digitisation, software and processing power create new dilemmas, perceived necessities and possibilities for enterprises and indeed for accounting activities in those enterprises. On data, information and knowledge, we have pointed to the possibility of wider and different types of knowledge roles being played by different parts of organisations which have developed over time and which may benefit from complementarities with rather than substitution by novel pathways being presented by Big Data and the emerging business analytics technologies. At the same time as ‘technologising’ and ‘informating’ the business world, accounting professionals may increasingly be compelled to be responsive to the limits, dangers and wider consequences of the connectivity these developments bring.

In relation to strategy and structure links and the relationship to accounting, we have stressed that recognising the value of ‘Big Data’ and developing the ability to apply data analysis techniques is for many companies an essential path allowing their executives to act on empirical information – both structured and unstructured in developing market and strategic intelligence with cognizance of the competition and customer behaviour trends. In such contexts, there exists little sequential linearity between strategy–structure and information systems design. On changing cost structures, alterations in the cost mix of products and shifts in cost behaviour will require not a dispensation of decision-making approaches which have long been established but a re-assessment of how cost changes can translate into alternate and renewed business strategies. Approaches to capture such changes will increasingly be demanded of providers of financial management and management accounting information.

The distance between analysis and execution by managers is being eliminated in enterprises adopting Big Data technologies. The practitioner’s understanding of performance metrics, management assessment parameters and incentives must increasingly be appealed to in setting up new responsibility and reward structures in enterprises. But even as executives in specialist functions move towards Big Data and business analytics, we argue that this requires an understanding of managers’ altering reliance on information and their appeal to a different and evolving knowledge base resting on both economic transactions information as well as ‘data exhaust’.

On outsourcing, we have noted that these activities will likely continue to grow and information executives will need to build capabilities for leveraging external service providers. In refocusing, these executives will also need to develop more coherent strategies on data, information and knowledge and their fit with assessing business and sourcing strategies. This may become critical if, as we envisage, the fundamental trend is accelerating towards digitally enabled business activities. As the vehicles for this trend, cloud computing, along with social media, Big Data/analytics software and mobile technologies present potentially radical challenges to all organisational activities, and indeed to the fundamental form of the organisation itself. Here there is the need not only to assess how to progress with the adoption of such technologies in a phased manner, but also redesign internal understandings of the value of data, information and knowledge flows, and their management. We see the trends we have discussed in this article as indicative of potential changes not only for providers of accounting information but also as pointing to possibilities for research focused on issues concerned with strategy-control links, cost management complexities, outsourcing and cloud-based technologies and the panoply of financial reporting and management

accounting consequences tied to advances towards Big Data and business analytics activities. The transformation of accounting information has been, so far, a slow train coming, but as the new technologies are increasingly applied they will accelerate the rate of change. Digitisation and automation are set to reach dramatically higher levels over the short term. An examination of the data, information and knowledge implications will increasingly be considered essential for accounting professionals given the extreme velocity of change confronting information structures currently.

Note

1. By 2013 global outsourcing contract value for business and IT services was about \$US648 billion (BPO \$304b., ITO \$344b.). On some estimates the market will see 4.8% compound annual growth through to end of 2017 as more is outsourced, and new service lines and delivery locations are added (Fersht and Snowden 2013). Within this, offshore outsourcing exceeded \$100 billion in revenues in 2013 and is estimated to grow at 8–12% per year to 2017 (Lacity and Willcocks 2012a, 2012b, 2012c). In 2013, IT and finance and accounting (F&A) administrative processes dominated outsourcing plans. In BPO, F&A has tended to be at the forefront of growth predictions, with 40% of organisations planning to increase the scope of their F&A outsourcing in the 2013–2015 period. By 2013 the global market revenues for F&A outsourcing were \$25 billion, with growth expected to continue at 7.6% annually to 2017, with regional variations across Asia Pacific, EMEA, Japan, North and Latin America (Fersht and Snowden 2013, Cullen *et al.* 2014).

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